

IMPERIAL INSTITUTE
OF
AGRICULTURAL RESEARCH, PUSA.

All Rights Reserved.

The

Journal of the South African Forestry Association

No. 2. April, 1939

PRETORIA
PUBLISHED BY THE ASSOCIATION
April and October

Price to Non-Members: 6/- Net.

SOUTH AFRICAN FORESTRY ASSOCIATION

Patron:

HIS EXCELLENCY THE GOVERNOR-GENERAL,
THE RIGHT HON. SIR PATRICK DUNCAN, G.C.M.G., K.C.

President:

COLONEL THE HONOURABLE DENEYS REITZ, M.P.

Vice-Presidents:

HANS MERENSKY, ESQ., DR.ING.H.C., D.SC.

P. R. VILJOEN, ESQ., M.R.C.V.S., DR.MED.VET.

COLONEL THE HONOURABLE W. R. COLLINS, M.P., D.T.D., D.S.O.

H. J. VAN DER BIJL, ESQ., PH.D., D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.

OFFICERS:

Chairman: J. D. KEET, ESQ., DIP.FOR., M.SC. (HON.)

Vice-Chairman: H. A. READ, ESQ., F.S.A.A.

Hon. Editor: J. M. TURNBULL, ESQ., DIP.FOR.

Hon. Secretary-Treasurer: W. E. WATT, ESQ., A.F.C., B.A., DIP.FOR.

Executive Committee:

J. D. KEET, ESQ., DIP.FOR., M.SC. (HON.), (*Chairman*)

H. A. READ, ESQ., F.S.A.A. (*Vice-Chairman*)

CONNELL O'C. MAGGS, ESQ., B.A., B.SC.

PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.

O. K. SCHLIMMER, ESQ.,

J. M. TURNBULL., ESQ., DIP.FOR. (*Editor*)

W. E. WATT, ESQ., A.F.C., B.A., DIP.FOR. (*Sec.-Treas.*)

EDITORIAL COMMITTEE.

I. J. CRAIB, ESQ., M.F., PH.D.
PROFESSOR E. J. NEETHLING, B.A., M.F.
A. J. O'CONNOR, ESQ., DIP. FOR.
PROFESSOR JOHN PHILLIPS, D.Sc., F.R.S.E., F.L.S.
J. M. TURNBULL, ESQ., DIP.FOR.—*Editor.*

Contributions on any aspect of forestry or allied subjects will be considered by the Editorial Committee, and should be addressed to the Editor, The Journal of the South African Forestry Association, P.O. Box 727, Pretoria. Articles in excess of 1,000 words should be accompanied by uncopyrighted summaries, not exceeding five per cent. of length of originals. Twelve reprints of each article will be furnished to its author, free. Reprints beyond that number may be obtained, if ordered before the end of the month preceding that of issue, at the following rates per unit of four text pages:—

100	*copies*	£0 16 6
250	,,	£1 5 6
500	,,	£2 0 6
1,000	,,	£3 10 6

Incomplete units will be charged as for complete units. Printed covers ordered at same time as the text will be provided at 21/6 per 1,000, and 2/- for every 50 in excess thereof. Illustrations extra by arrangement.

Articles will be published in the language in which they are submitted.

The Association does not hold itself responsible for statements or views expressed by authors.

Readers are urged to consider the Association's advertisers as occasion may arise.

REDAKSIE-KOMITEE.

MNR. I. J. CRAIB, M.F., PH.D.
PROFESSOR E. J. NEETHLING, B.A., M.F.
MNR. A. J. O'CONNOR, DIP. FOR.
PROFESSOR JOHN PHILLIPS, D.Sc., F.R.S.E., F.L.S.
MNR. J. M. TURNBULL, DIP.FOR.—*Redakteur.*

Artikels oor alle aspekte van bosbou sal deur die Redaksie-Komitee in oorweging geneem word, en moet aan die Redakteur, ,,The Journal of the South African Forestry Association,'' Posbus 727, Pretoria, gerig word. Artikels van meer as 1,000 woorde moet van 'n opsomming van nie meer as vyf persent van die lengte van die artikel self, waarvan kopiereg nie voorbehou is nie, vergesel word. Twaalf herdrukke van elke artikel sal kosteloos aan die skrywer daarvan verskaf word. Mits hulle bestel word voor die einde van die maand voorafgaande die van uitgawe, kan herdrukke bo hierdie hoeveelheid teen die volgende pryse vir eenhede van vier teksblaaie verkry word :—

100 *kopies*	£0	16 6
250 ,,	£1	5 6
500 ,,	£2	0 6
1,000 ,,	£3	10 6

Onvolledige eenhede sal teen dieselfde prys as volledige eenhede gereken word. Gedrukte omslae, bestel gelyktydig met die herdrukke, sal voorsien word teen 21/6 per 100, en 2/- per elke 50 bo die eerste 100. Illustrasies ekstra.

Kontribusies sal gepubliseer word in die taal waarin hulle ingestuur word.

Die Vereniging neem geen verantwoordelikheid vir bewerings of opinies van skrywers nie.

Lesers word versoek om die Vereniging se adverteerders waar gerieflik, in aanmerking te neem.

CONTENTS

The Association does not hold itself responsible for statements or views expressed by authors.

PAGE

EDITORIAL NOTES 1

THE JOURNAL.

THE WOODCUTTERS' ANNUITY ACT.

THE IMPERIAL FORESTRY BUREAU.

THE EMPIRE FORESTRY ASSOCIATION.

A VISITOR FROM JAVA.

THE NATIVE ATTITUDE.

PRESERVERING VAN HOUT.

KINGWILLIAMSTOWN HARBOUR.

IMPROVED STATUS OF GOVERNMENT FORESTERS.

RECLAMATION OF PORT ELIZABETH DRIFT SANDS, *by N. L. King, Dip.For.* 5

THE PRESERVATION OF WOOD, *by J. H. van Wyk, M.Sc., M.F. and P. J. A. Loseby, B.A., B.Sc.* 11

A PRELIMINARY REPORT ON SOME ASPECTS OF WATTLE PATHOLOGY, *by R. P. Stephens, B.A. (Cape), B.A. (Oxon), and W. B. Goldschmidt, B.Sc.* 31

WOODEN HOUSES, *by H. A. Read, F.S.A.A.* 44

THINNING, PRUNING AND MANAGEMENT STUDIES ON THE MAIN EXOTIC CONIFERS GROWN IN SOUTH AFRICA, *by I. J. Craib, M.F., Ph.D.* 49

PULP AND PAPER MAKING AS A SOUTH AFRICAN INDUSTRY, *by P. J. A. Loseby, B.A., B.Sc.* 56

WAT STEEK DAAR IN 'N NAAM, *deur A. W. Winckworth* 70

TEMPORARY TIMBER CHUTES AT DE HOEK PLANTATION, *by D. W. Pearse, B.A., Dip.For.* 72

CORRESPONDENCE 75

WEANING THE NATIVES FROM THE NATURAL FORESTS IN THE NATIVE TERRITORIES.

MINING TIMBER.

REVIEWS 79

THE ANNUAL REPORT OF THE DIVISION OF FORESTRY.

PUBLICATIONS RECEIVED... 81



J. D. M. KEET, Esq., M.Sc.(Hon.)
DIRECTOR OF FORESTRY
FOR THE UNION OF SOUTH AFRICA.

THE JOURNAL OF THE
SOUTH AFRICAN FORESTRY ASSOCIATION.
No. 2. APRIL, 1939

EDITORIAL NOTES AND COMMENTS

THE JOURNAL.

Judging by the favourable notices it has received both at home and abroad, the launching of our Journal has been attended with marked success. The thanks of the Association are due to our kindly critics, not excepting one who has been provoked to merriment by discovery in its pages of "conservation in its wi(l)dest sense." To our contributors, advertisers, and readers, and all to whom we have been indebted for active assistance or valuable advice, we are no less grateful. All apprehension regarding future supplies of copy are so far dispelled that we are now, in the irony of things, menaced with paucity of space; and, with exception of the annual report of the Division of Forestry, which as a survey of the progress of State forestry during the year concerned, could not be allowed to pass unnoticed, we have been reluctantly compelled in the present issue to withhold a number of reviews. The prompt use of many valuable contributions now on hand, without contravening the Association's constitution, will necessitate a considerable increase in the size of future issues. To make this financially possible we would urge individual members to undertake a little local canvassing for membership.

THE WOODCUTTERS' ANNUITY ACT.

For upwards of a century the indigenous forests of the Knysna region have been exploited far beyond their productive capacity. With a view to stemming their rapid depletion—private forests in the region, be it noted, are already with few exceptions, completely exhausted—a register was compiled in 1913 of all persons whose main livelihood was derived from working wood in them, and legislative authority obtained to restrict such working strictly to persons figuring on the register at the time of compilation. It was hoped that the gradual elimination of registered privileges would secure equilibrium between exploitation and natural increment before considerable further damage was wrought. An elaborate stocktaking undertaken between 1927 and 1929, however, disclosed an appaling drain on forest capital menacing the welfare not only of the woodcutters, but of local woodworking industry also, and all whose livlihood was in any way dependent on either.

The stocktaking report indicated that maintenance of an already weakened sylvicultural condition in the region demanded curtailment of the total yield for the period 1930 to 1970 to 7,314,000 cubic feet. In an effort to keep the woodcutters provided with wood, forty-five per cent. of this total, deriving from eighty per cent. of the legitimately exploitable forest area, has already been extracted. In other words, in spite of a reduction in the number of woodcutters from 1,267 in 1913, to 259 at the beginning of this year, the forests, since 1930, have been exploited almost exactly twice as heavily as they can bear.

The impoverished condition of the forests, combined with concessions to the woodcutters in the shape of reduced tariff prices, has involved a considerable loss to the State, both in capital and revenue. The loss in net revenue alone incurred since 1913 is estimated at over £300,000.

An Act just passed, under the title of The Woodcutters' Annuity Act, provides for the pensioning off as from 1st April of this year, of all registered woodcutters, with an annuity of £25 per annum each, payable from the Consolidated Revenue Fund, until they qualify for the Old-Age Pension on attaining the age of 65; or at death, should they not reach that age. The amount of the annuity is based on the beneficiaries' average earnings in the forests over a considerable number of years. The award is forfeitable only on conviction for certain well-defined forest offences.

This solution of an age-long problem will have generally beneficial results. While the State, with the resources at its command, will be able to turn to better account a yield adjusted so as to disturb local woodworking industries as little as possible, and to effect less harmful felling and extraction of timber from the forests, the woodcutters will continue in receipt of an annuity in excess of what, owing to imperative future curtailment in yield, they would have earned under the old system. There will, moreover, we learn, still be considerable State employment in the forests open to such of them as may be unsuccessful in, or averse to, finding employment in other spheres. Their future earnings will in no way affect the amount of the annuity.

The Imperial Forestry Bureau.

The Imperial Forestry Bureau that has recently been established by the Executive Council of the Imperial Agricultural Bureaux, should meet a long-felt want. The usefulness of the literature on forestry that issues annually in many languages from the Press of all countries has hitherto been defeated by its very volume. In the January issue of the *Current Monthly Record of Forestry Literature,* the first to be put out under the aegis of the Bureau, the 152 titles recorded form merely a selection of what was actually available during the period. It will be the function of the Bureau to digest this huge volume, and present its more important contents in assimilable form for the information of those engaged in the practice or study of forestry. Liaison with the Imperial Forestry Institute, at Oxford, will be secured by placing the Bureau under the general control of the head of that institution, who will assume the title of Director. Executive control will be in the hands of a Deputy Director, yet to be appointed. While the Bureau, itself,

which is supported by contributions from the Dominion Governments, is independent of the University, the bridge thus provided should ensure for it ready access to resources vested peculiarly in that body, not least of which is its extensive forestry library. Initiation of the Bureau marks an important advance in the co-ordination of forestry endeavour, and we look forward with pleasurable anticipation to the first fruits of its beneficient leavening.

THE EMPIRE FORESTRY ASSOCIATION.

South African readers will in future miss the familiar name of C. E. Legat on the green cover of the *Empire Forestry Journal*. Mr. Legat assumed the position of Editor-Secretary to the Empire Forestry Association some three years after his retirement as Chief Conservator of Forests in South Africa, and for the five years ending last December has maintained the high standard of the Association's Journal with unvarying regularity. He has now retired, and we wish him the fullest enjoyment of a well-earned leisure.

The last issue of the Journal was edited by Mr. R. C. Milward; but the substantive incumbent of the joint post is Mr. H. R. Blandford, O.B.E., late Chief Conservator of Forests for Burma, to whom we wish every success.

Many members of the South African Forestry Association are also members of the Empire Forestry Association, which is as it should be; and it were well that still more join. Through its Journal, as well as in other ways, the Association exerts a strong co-ordinating influence on forestry in the Dominions and Colonies; and it has long been the aim of its Council, when membership becomes sufficiently large, to issue the Journal four times a year instead of merely twice as at present.

Full particulars of membership may be obtained from the Honorary Local Secretary, P.O. Box 727, Pretoria.

A VISITOR FROM JAVA.

Mr. M. A. F. Dijkmans, Chief Forest Officer for Western Java, is at present touring the Union on behalf of the Netherlands East India Government. His tour is partly commercial—seeking new outlets for the products of the Batavian forests—and partly technical. His technical interests cover a wide field, including investigation of exotic species with regard to their suitability for the afforestation of some of the widely varied altitudinal zones encountered in the Dutch East Indies. In this connection, Mr. Dijkmans has expressed amazement at the phenomenal growth of certain Eucalypt species that he has seen in plantations on the Zululand coast. Logging, milling, timber preservation and seasoning, and the wattle bark industry have also each engaged the close attention of this very welcome visitor.

THE NATIVE ATTITUDE.

That this Council respectfully requests the South African Native Trust to provide more adequate protection of undemarcated forests.

The above resolution was put forward by a native councillor at the 1938 session of the Transkeian Territories General Council. We had occasion to remark in our last issue on a similar request by a native ruler in Uganda; and it is encouraging to find a spontaneous urge to obliterate a reproach that has for long attached to natives in the Union, now voiced by one of their own spokesmen.

PRESERVERING VAN HOUT.

Afgesien van die inhoud van artikel vii/8 van die konstitusie van die Vereniging, en sonder enige voorneme om 'n presedent te skep, is dit besluit om die artikel, „The Preservation of Wood," deur mnre. Van Wyk en Loseby, wat in hierdie nommer verskyn, weens die belangrikheid daarvan vir boere, bouers, ens, in die nommer vir Oktober, 1939, in Afrikaans te laat herdruk.

KINGWILLIAMSTOWN HARBOUR.

Many readers must have been puzzled by the reference to Kingwilliamstown Harbour on page 8 of our last issue. This topographical anomaly arose from an excision made in proof without adequate regard to context. Insertion of the words "at Port Elizabeth" in line 13, after the words "drift sands" will effect the necessary rectification of the Union's coast line.

The author of the "Historical Sketch," in which this error occurred, deals with the reclamation of these sands at greater length in the present issue.

IMPROVED STATUS OF GOVERNMENT FORESTERS.

At the moment of going to Press we learn with satisfaction that the posts of foresters in the Government Service are included, as from 1st April, in the Professional Division (Lower) of the Public Service. We wish to congratulate all officers concerned on the improvement in their status, and the recognition of the responsible and professional nature of their work which the change implies.

RECLAMATION OF THE PORT ELIZABETH DRIFT SANDS.

By N. L. King

(Chief Management Officer, Division of Forestry)

THE reclamation of the Port Elizabeth drift sands may be regarded as one of the outstanding achievements of the forest service. The work which took sixteen years to accomplish has not only overcome the menace to the harbour and town, but has transformed over 11,000 acres of barren waste into a thriving plantation which is restoring fertility to the soil and, at the same time, is yielding a handsome revenue from the sale of fuel. Further, the value of the land, once practically useless, has been enormously enhanced as residential or industrial sites.

Only those who knew the area as a wilderness of blinding white sand and were engaged on the reclamation work can appreciate fully the magnitude of the task, the difficulties encountered and the transformation that has been wrought.

The drift which covered an area about eleven miles long by half a mile wide at the western extremity and two miles wide on the eastern side, stretched from a point called Governor's Kop to Algoa Bay. This long wedge-shaped strip of moving sand commencing on the beach at Governor's Kop gave one the impression that it was entirely of marine origin. Against this there is evidence that, as late as 1890, old men living at Port Elizabeth remembered when portion of the devastated area was a well wooded and fertile tract of country. It is also stated that the drift was caused by the destruction of bush and other vegetation by lime burners, veld fires and overgrazing. The probable explanation is that, in addition to the ingress of sand from the beach at Governor's Kop, the sandy soil between Schoenmaker's Kop and Algoa Bay was set in motion at various points and the drifts thus formed gradually merged into one. Their resemblance to sands of marine origin would be accounted for by the removal of organic matter and finer particles by rain or wind.

The sand drifted into Algoa Bay at Sharks River and was carried by the current towards the harbour and threatened to silt up the jetties. Inland, an offshoot from the main drift was advancing towards the south end and would have engulfed that part of the town in course of time. Near Schoenmaker's Kop the sand continually interfered with the public road and great difficulty was experienced in keeping this section open to traffic. For these reasons the Harbour Board, Town Council and Divisional Council were directly interested in the reclamation of the sands. When Government undertook the work the Harbour Board and Divisional Council contributed directly towards the cost by annual cash payments. The assistance rendered by the

Town Council consisted merely of delivering town refuse into trucks instead of dumping it elsewhere. Previous to this the Harbour Board had, single-handed, attempted to arrest the sands. For seventeen years operations were carried out in the section between Governor's Kop and Schoenmaker's Kop at a total cost of round about £34,000. This work later on proved to be of immense value to the Forest Department as the plantation which had been established, provided all the bush required for building up the littoral dune and also for the reclamation of the extreme western section of the drift.

About 1890, Mr. Webber, who was Conservator to the Harbour Board and who had charge of the reclamation work, estimated that a further sum of £241,500 would be needed to bring it to completion. This estimate was based on reclamation by means of bush costing £21 per acre if the material had to be purchased. If sufficient material could be obtained from existing plantations, the amount required would be reduced to £172,500 or £15 per acre. He did not think that convict labour would be cheaper than free labour or town refuse cheaper than bush. In either case the amount needed was beyond the resources of the Harbour Board who began negotiations with Government to assume responsibility.

The matter was referred to the late Mr. J. Storr Lister, Conservator of Forests, Kingwilliamstown, who was asked to submit his views on the suggestions. He not only strongly advocated that, in the public interests, the State should undertake the work, but went further and drew up a scheme based on the same method he had inaugurated for the reclamation of the drift sands at Bellville near Cape Town. Briefly, the scheme was to fix the sands temporarily by spreading town refuse over them and then to establish Rooikrans* and Port Jackson wattles (*Acacia cyclopis* and *A. saligna*†) to provide a permanent covering. Seeds of Rye and Pyp grass (*Ehrharta gigantea*) were to be sown at the same time as the wattles to protect the latter against wind.

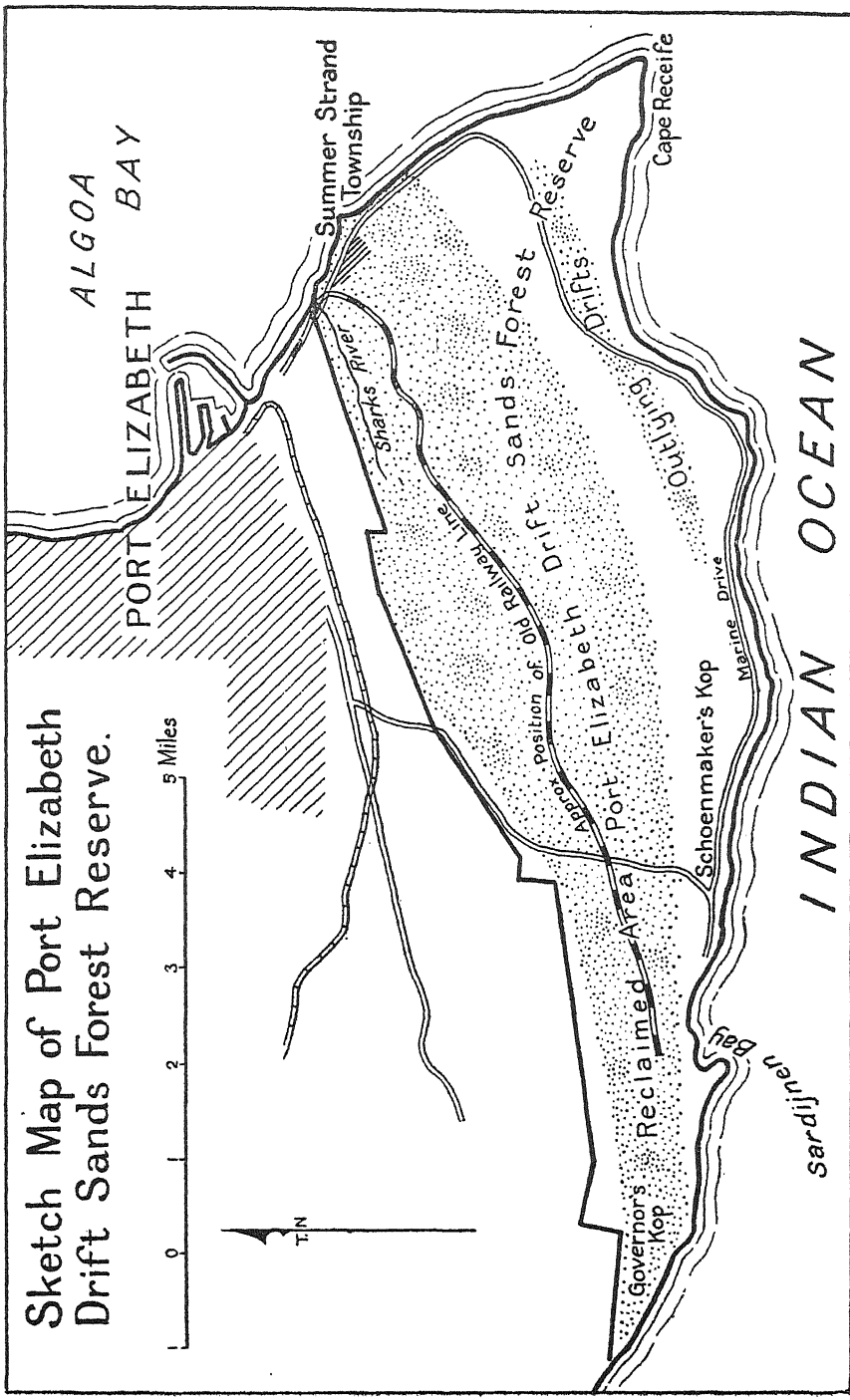
For the conveyance of rubbish from Port Elizabeth, the scheme provided for the construction of a railway line to Sharks River and extension from there through the centre of the drift as reclamation proceeded. The rubbish would be dumped at convenient points for distribution by means of tramways and convict labour used for spreading it over the sands. Reclamation would thus begin on the Algoa Bay side and serve the immediate object of preventing further quantities of sand from drifting into the bay. The total cost of the scheme, including the expropriation of certain properties, was estimated at £51,480 spread over a period of sixteen years.

The recommendations were accepted but a commencement was not made until three years later when, on the 1st June, 1893, the late Mr. T. Hare, District Forest Officer, was transferred to Port Elizabeth to take charge of the operations. He quickly got the work under way and in a year or two it became evident that the method adopted would prove entirely successful.

---

*Rooikrans. An Afrikaans word which means "red garland" and refers to the red aril surrounding the seed.

†The tree known as *A. saligna* is said to be *A. cyanophylia*.


Sketch Map of Port Elizabeth
Drift Sands Forest Reserve.
0
1
2
3
4
5 Miles
T.N
ALGOA
BAY
PORT ELIZABETH
Summer Strand
Township
Sharks River
Approx. Position of Old Railway Line
Port Elizabeth Drift Sands Forest Reserve
Outlyings
Drifts
Cape Receife
Reclaimed Area
Governor's Kop
Schoenmaker's Kop
Marine Drive
Sardijnen Bay
INDIAN OCEAN

Details of technique were developed as reclamation proceeded. It was found necessary to sort the rubbish before spreading it on the sands as wind scoured holes round bulky articles. It was also found that a thickness of half an inch of rubbish was sufficient for the temporary fixation of sand. About eleven truck loads or roughly forty-four tons of unsorted rubbish were required per acre. Altogether during the course of the work 58,571 truck loads were utilised. The rubbish contained a large amount of animal manure from stables and street sweepings, which not only stimulated the growth of plants, but provided sufficient seed to furnish a crop of oats for supplementing the grain rations fed to the mules employed on drawing the trams. At the end of each day's work the edges of reclaimed areas were protected by a narrow strip of bush, otherwise the rubbish on the margin was apt to be buried by sand blown in from outside. Seeds were sown before the rubbish was spread in order that they should be trodden in by workmen. The rubbish prevented sand movement until the seeds germinated and the oats and pyp grass protected the wattle seedlings until they became established. Certain outlying drifts which could not economically be reclaimed with rubbish were dealt with by covering them with bush and sowing grass and wattle seeds in the usual way.

In the initial stages of the work, it was realised that steps should be taken to cut off the ingress of sand from the beach at Governor's Kop by creating an artificial dune. This dune was built by placing barriers made of bush some distance back from high-water mark. As they were buried, fresh ones were erected on top until sufficient height was reached to give the windward face the requisite degree of steepness to prevent sand being driven by wind to the summit. The total length of dune thus created was about two and a half miles long and forty feet high. The seaward slope was then planted with Marram grass (*Psamma arenaria*) which proved satisfactory although its growth was not as good as in the winter rainfall area of the Western Cape Province. Constant attention was and is still necessary to maintain the dune which is apt to be breached during heavy winds. Breaches must be filled at once by bushing until sufficient sand has been collected to fill the gap. The effect of the dune is to deflect sand along the beach towards Sardijnen Bay where, at a bend in the coast line, it is shot back into the sea.

Mr. Hare died in May, 1898, and was succeeded by Mr. E. B. Dwyer under whose able administration the work was carried on and brought to a conclusion in 1909.

It is worthy of note that reclamation was completed almost exactly within the time estimated by Lister, and that the cost exceeded the estimate by a matter of only £9,520. The excess was largely due to increased charges for convict labour and haulage of rubbish trucks. Since then maintenance charges have increased the cost to £95,577, but as an offset against this £56,445 has been derived as revenue and leaves the nett cost at £39,132. It is probable that in course of time the entire expenditure will at least be recouped.

As would be expected, the handling of refuse was anything but pleasant on account of the objectionable smell and myriads of flies which bred on the dumps. The warders and convicts, however, appeared to suffer no ill effects. Several mules died from tetanus, the germs of which were presumably introduced in the rubbish and gained entrance through punctures of the frogs by nails which were difficult to discover and which excluded air.

As the plantation developed, snakes became extraordinarily numerous, probably as a result of the cover provided and the plentiful food supply that became available in the form of rodents which bred in the dumps. The late Mr. Williams, well known as a snake catcher, spent many a profitable Saturday afternoon on the reclaimed area.

The cover afforded by the trees also resulted in a large increase in game. Duikers, grysbok, guinea fowl and pheasants became plentiful and afforded a good deal of sport to the inhabitants of Port Elizabeth. As a result of depredations by poachers, especially spot light poachers, it became necessary to close the forest reserve to hunting in 1930 except the Receife triangle, where hunting under licence is permitted without dogs.

For many years plantation wood was not saleable on account of the prejudice which existed against it and for the further reason that householders had long been accustomed to slow grown indigenous wood of high calorific value, which was obtainable from the Addo Bush. Departmental exploitation was tried and although the nett return hardly justified the labour and expense involved it served the purpose of bringing the wood to the notice of the public. At the writer's suggestion this method was abandoned in 1915 and in lieu thereof a section of the plantation was cut up into plots of various sizes which were offered for sale at fixed prices depending upon the amount of wood on each. This experiment succeeded beyond the most sanguine expectations and has become the accepted method of disposing of firewood from this centre. Many persons have now taken up the firewood business as a means of livelihood and are dependent solely on supplies from the drift sand plantation. As an indication of the extent of the trade it may be mentioned that during the three years ending March, 1938, 852,191 cubic feet of firewood were disposed of and realised £3,553. The wood of *Acacia cyclopis* is preferred as it burns more readily than that of *Ac. saligna* and is said to have a higher calorific value.

No difficulty is experienced in securing natural regeneration on areas that have been clear felled. Regrowth is, in fact, too profuse, especially in places where fires have occurred, and, as a result, suppression sets in at a very early age and retards development. Resort to spacing may be necessary to provide young plants with sufficient growing space. The problem is at present not urgent, as ample supplies of wood are available for many years to come. Incidentally it may be mentioned that *Ac. cyclopis* is ousting *A. saligna* except on scoured ground in between the waves of former sand dunes. Of the two, *Ac. cyclopis* is, in many respects, better than *A. saligna* for drift sand work. It is not only more resistant to sea winds and will thrive

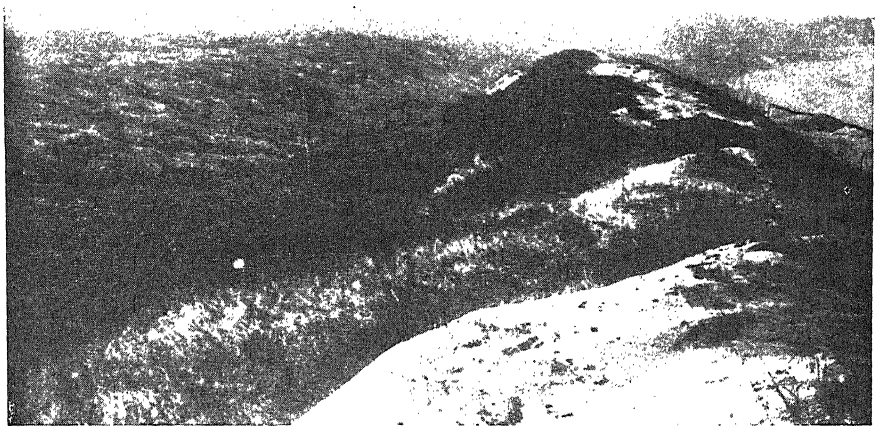
in exposed situations where *A. saligna* will fail, but has a more bushy habit of growth, provides denser cover, adds more organic matter and appears to improve the fertility of the sand more than *A. saligna*. In places near the sea where *A. cyclopis* is being removed to provide picnic sites, a luxuriant growth of quick grass rapidly covers the ground. Market gardeners on the Cape Flats assert that potatoes can successfully be grown on sands reclaimed with *A. cyclopis* whereas this is not so in the case of *A. saligna*.

An objection to the use of *A. cyclopis* is that it rapidly spreads into the veld particularly if the soil happens to be of a sandy nature. Its spread is due to birds which void the seeds after digesting the fleshy red arils with which the seeds are surrounded.

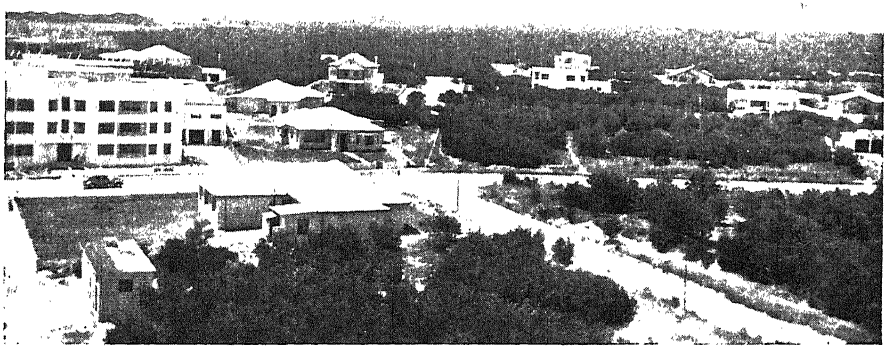
Many other tree species were tried on the drift sands but speaking generally, they have not proved a success. *Eucalyptus gomphocephala, E. diversicolor* and *E. cornuta* planted on the leeward side of dunes have done fairly well, but are dwarfed by winds which cut back the leading shoots as soon as they get above the protection afforded by the wattles on the summits of the dunes.

The plantations are adding large quantities of organic matter to the reclaimed area and will, no doubt, slowly but surely, bring about a great improvement in the fertility of the area. It is easy to visualise the day when a pleasant suburb will arise from what was once a barren waste. Already on portions taken over by the Divisional and Town Councils, a magnificent marine drive has been constructed, golf links established and building operations are in progress.

Few of the people of Port Elizabeth remember the day when the sands were not only an eyesore, but a menace. They are consequently unable fully to appreciate the inestimable benefit of the plantation on the establishment of which so much money and labour has been expended. As stated in the opening paragraph, the site value of land, once practically useless, has been raised enormously. A piece of ground excised from the forest reserve a few years ago was cut up into building plots and sold by public auction. The plots actually sold realised an average price of £1,485 per acre.



The Littoral dune at Governor's Kop, Port Elizabeth in 1914. The grass in foreground is *Ehrharta gigantea*. *Acacia cyclopis* can be seen on leeward side of dune and Marram grass near the beach.



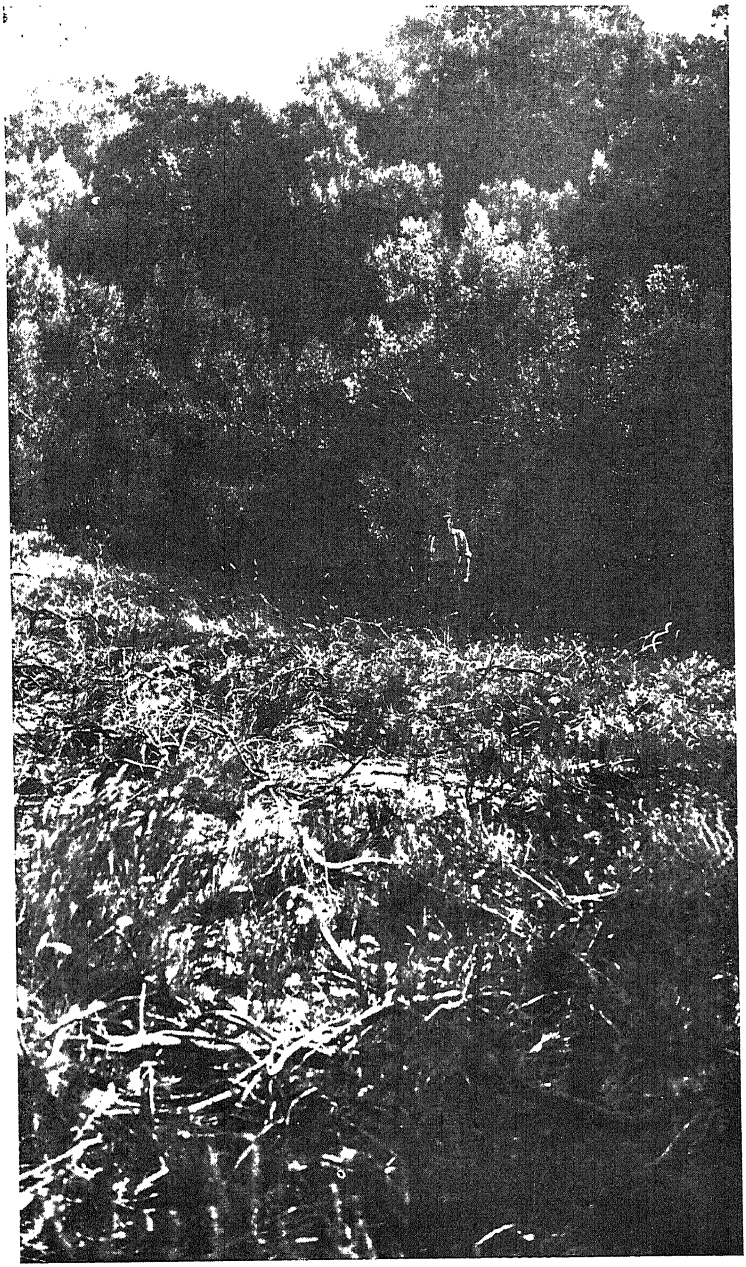
Southern portion of Summer Strand—a suburb of Port Elizabeth on reclaimed drift sands.



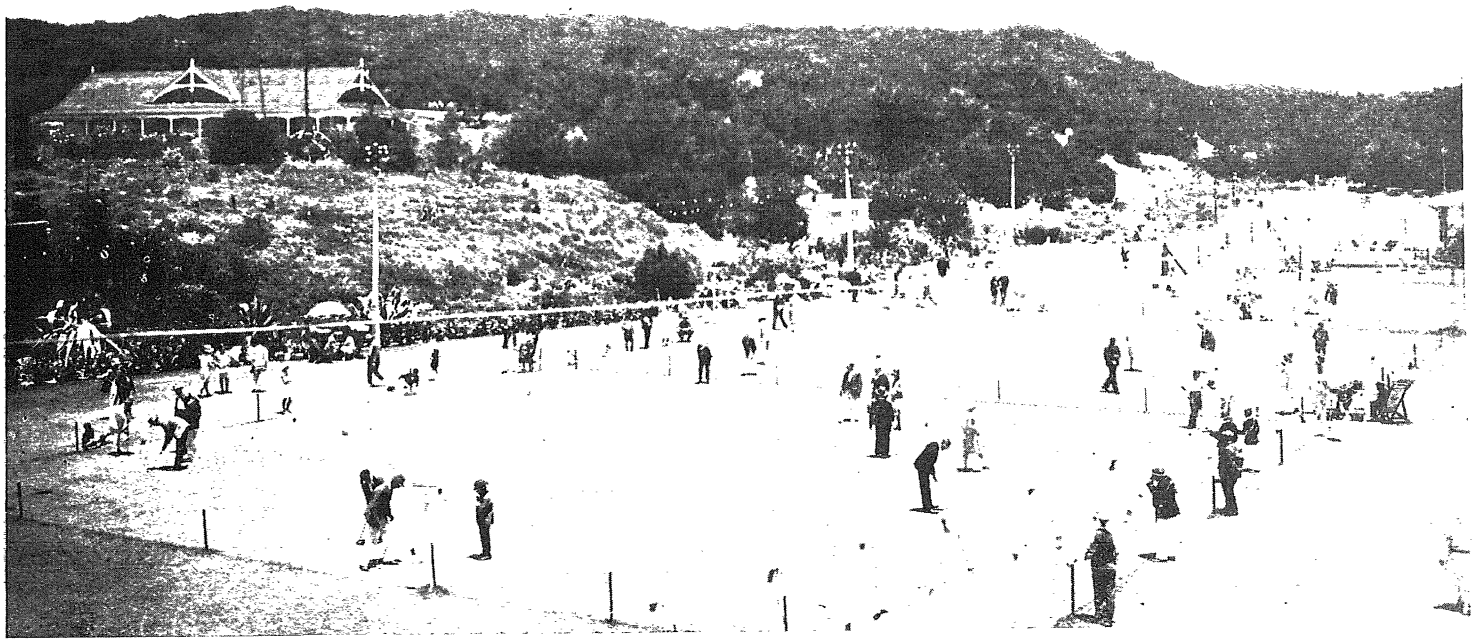
Spreading refuse on drift sand at Port Elizabeth.



Tram used for transportation of refuse to sand dunes on Port Elizabeth drift sands. Note bush screen used to protect edge of reclaimed area.



Sand dune on Port Elizabeth drift sands forest reserve permanently clothed with vegetation. The trees are *Ac. cyclopis*.



Happy Valley, Port Elizabeth, formerly known as Sharks River. The valley was silted up by drift sand and after reclamation was converted by the municipality into the pleasure grounds shown above. The trees on the sand hills in the background are *Ac. cyclopis.*

Photo by S.A.R. & H.

THE PRESERVATION OF WOOD.

By J. H. van WYK and P. J. A. LOSEBY
(Forest Products Institute, Pretoria)

WOOD preservation is the lasting protection of wood against all agencies which tend to cause its deterioration and destruction. The wood preserver endeavours, by various processes, to render wood as toxic or repellent as possible to these agencies, and so obtain the greatest possible service from it. The oldest and most efficient means of achieving this end is impregnation with antiseptic chemicals.

I. The Development of Wood Preservation in South Africa

In early times South Africa's only supplies of home-grown timbers were, with few exceptions, non-durable; and, while the few durable species, such as Sneezewood and others, were eagerly sought after, their limited supply could do little to mitigate a growing conviction that the use of home-grown wood for fence posts, telegraph and transmission poles was not worth while. It was justifiably regarded as false economy to use wood which, in the space of a very few years, would be devoured by termites, destroyed by decay, or riddled by the larvae of wood-boring beetles.

After the Government had set to work to augment the limited natural timber resources of the country by means of a vigorous policy of afforestation with exotic species, it soon became a problem to find outlets for the utilization of increasing quantities of pole timbers, the great majority of which were not durable. The question was tackled scientifically and necessity thus heralded the birth of a practice new to South Africa—that of wood preservation.

From a small beginning in 1922, the Union Forest Department has steadily extended its operations in the sphere of wood preservation. Treating schedules have been devised for almost every exotic species of timber grown in this country, and the perfecting of technical processes has been steadily advanced. The outstanding feature of the work, however, has been the testing of the relative merits of known preservatives and specially devised mixtures of preservatives by means of actual service tests. The repellence of these chemicals to termites has been evaluated at a site at Pienaar's River, Pretoria District, a locality in which the prevalence of termites is particularly high. Here small specimens have been interred and subjected to periodic inspection. The relative toxicity of the preservatives to wood-rotting fungi has been determined by controlled small-scale trials conducted at a deep level in one of the Witwatersrand Gold Mines. The work has, however, not been confined to small specimens, but the more promising preservatives have been subjected to extended

trials of full size products in actual service. Thousands of treated telephone poles, electric transmission poles, sleepers and fence posts have been placed in service in widely different localties in all parts of the country and have been carefully inspected from time to time.

The excellent results obtained have prompted the establishment of treating plants on a commercial scale, five of which are now operating in various parts of the country. As the consumer has learnt to appreciate the advantages of wood preservation, the demand has increased sharply, until to-day difficulty is found in supplying all the material called for. It can now be confidently asserted that the technique of wood preservation has been placed on a sound practical foundation, and there is little doubt that the use of preserved timber is taking its place in the national economy of South Africa.

The Forest Products Institute, Pretoria West, is the headquarters of wood preservation, and the staff is eager to supply information on the subject and to answer all enquiries.

II. The Structure of Wood

Though, to the eye, wood appears to be a solid, compact substance, examination under the microscope reveals that in reality it is composed of a mass of hollow cells or tubes forming a structure somewhat resembling a honeycomb. The wood substance, then, consists of the walls of these cells which are composed of cellulose, and the substance known as lignin, which cements adjacent walls together. In the living tree, the cell cavities are filled with a watery liquid, or sap, which may account for as much as 66 per cent. of the weight of the green wood. As the wood dries out after the tree has been felled, the water evaporates and the cells become filled with air.

Hardwoods and Softwoods.

Woods are divided into two major groups, known as Hardwoods and Softwoods, though no definite degree of hardness separates the two. The difference between them is a botanical one, based on the structure of the seeds, and botanists refer to hardwoods as Angiosperms and Softwoods as Gymnosperms. The most accurate popular description of the groups defines hardwoods as trees with broad leaves, and softwoods as trees with needles or narrow scale-like leaves. Differences in botanical characteristics are again accompanied by differences in cellular structure.

The yellowwoods, cedars, cypresses and pines are classified as softwoods, while the great majority of our indigenous trees, and exotic gums, wattles, and other species fall into the group known as hardwoods. The significance of this distinction will be realised in subsequent discussion of certain aspects of the subject.

Sapwood and Heartwood.

If the trunk of a tree is cross-cut, the surface exposed often shows a dark coloured inner core surrounded by a lighter coloured shell. In the living tree the outer part of the stem contains the living cells and is termed Sapwood, while the inner core which has ceased to function physiologically is called Heartwood.

Although there is generally a marked difference in colour between sapwood and heartwood, as shown in photograph No. 2, in the case of some species the colour difference is hardly perceptible.

Wood Structure and Preservation.

A clear conception of the structure of wood is essential in order that the principles of wood preservation may be understood. For the lasting protection of wood, more than a thin surface coating of preservative is necessary; the wood requires to be permeated to some depth with the preserving liquid. It can, in fact, be stated that, other things being equal, the length of service obtained from treated wood is dependent upon the amount of preservative originally present in the wood.

In order to obtain the required penetration of preservative into the wood, it becomes apparent that sap which fills the cells in the living tree must first be removed. This is brought about by allowing the wood to dry out thoroughly before it is treated. The preservative is then forced into the empty cells by one of the methods to be described later.

Were the walls of the cells to be completely impervious to liquids, it would be impossible for the preservative to penetrate into the wood. Such penetration is, however, made possible by the presence of numerous small openings or pits in the cell-walls. In the heartwood of many species, this intercommunication is prevented by certain physiological changes in the wood, and the penetration is limited to the sapwood. It has been established, however, that complete penetration of the shell of sapwood affords efficient preservation to the pole as a whole.

III. Destructive Agencies

Timber in service, exposed to outdoor conditions, sooner or later loses its serviceability. In South Africa the deterioration or destruction of wood is brought about mainly through decay, termites and the larvae of wood-boring beetles.

Decay.

Decay is an organic process which results in the disintegration of the wood elements, and is caused by low forms of plant life called wood-rotting fungi. In order to thrive, wood-inhabiting fungi need air, moisture, a suitable temperature and food in the form of wood. Thus, wood submerged in water will not decay on account of the lack of sufficient air, while on the other hand, wood with a moisture content of less than 20 per cent. will also stay sound. This explains why furniture and interior woodwork made from seasoned wood last almost indefinitely. The optimum growth condition as regards temperature ranges between 65°F. to 95°F., and the ordinary temperatures during the summer months are therefore eminently suitable for the development of fungi. The low temperature prevailing during the winter months inhibits growth but does not kill the fungi, which remain dormant until the warm weather of the following spring. Under outdoor conditions, the moisture content of wood, especially

those parts in contact with the ground, is mostly above the minimum required by fungi, and such wood will therefore be liable to decay. The most vulnerable points are those parts of the wood at and just below the ground line and any joints, cracks, bolt holes and other crevices which allow of the retention of moisture.

The most practical way to prevent decay is to poison the food supply of the fungus by impregnating the wood with a toxic chemical.

Insects.

The larvae of the beetles of the genus *Lyctus,* or powder post beetles, cause a tremendous amount of damage to the sapwood of most hardwoods in South Africa, while other related genera cause considerable damage to softwoods in some parts of the country.

As practically all the building poles used for rough shed construction, as well as fence posts and other material are obtained from the thinnings of young immature plantations, they consist almost entirely of sapwood. The result is that many farmers and builders have had the experience of untreated timber being riddled by the larvae of these wood boring beetles within a few years.

Beetles which attack green wood are of less importance. Green hardwood poles are, however, subject to the attack of Phoracantha beetles immediately after they are felled, the larvae of which make holes quarter to half inch in diameter right into the heartwood. If the bark under which they otherwise harbour and breed is removed from poles immediately after felling, they are rendered immune against attack.

Termites.

Of all the wood destroying agencies the termites, or white ants, are probably the most voracious. There are more than fifty known species of wood destroying termites in this country, only a few of which, however, are of economic importance. They cause considerable damage in Natal, Transvaal, Orange Free State, Transkei and the Northern borders of the Cape Province.

Termites, like bees, are social insects, living in colonies with a queen and various specialized castes, each of which is especially fitted for a particular function. Castes are specially differentiated to carry on the duties of reproduction, protection and the gathering of food and maintenance of the nest.

The termites feed on wood which is devoured by means of hard, toothed mandibles resembling saw blades. The softer parts of the wood are generally preferred and termite damage is often typified by the hollowing out of the springwood, while the harder rings of summerwood remain intact. Strangely enough, the termites are unable to digest the wood but depend for its metabolism on the presence of numerous minute organisms in their intestines. The most serious damage in this country is caused by subterranean termites which attack wood in or on the ground and are also able, by means of galleries, to reach wood which is not in contact with the ground. Typical damage consists in the nibbling through of untreated wooden

posts at and below the ground line. Other species, known as dry-wood termites, do not inhabit the ground and are able to attack any wood which is within the range of flight of the winged form.

More effective than any other remedy for termite damage is the prevention of attack by means of a thorough impregnation of the wood with an effective preservative before it is put into service.

Other Agencies.

A type of wood destroying agency, of less importance in this country than the three mentioned, is the marine borer, which damages timber immersed in sea water.

Again, unpainted wood exposed to outdoor conditions soon acquires the well known weathered appearance caused by the repeated swelling and shrinkage of the outer fibres, due to change in moisture conditions. Such weathering affects the strength of wood and detracts from its appearance.

Fire is not regarded as a major hazard for the class of material under consideration. The greater part of the material so far treated with preservatives has to a large extent been placed under conditions where the sole fire danger, if any, is from veld fires. No case of destruction by veld fires of any of the many thousands of posts and poles placed in service tests in many parts of the Union since 1922 has been reported.

IV. Wood Preservatives.

The Properties of a Good Wood Preservative.

The essential characteristics of an efficient wood preservative are as follows:—

1. It should be highly toxic or repellent to the wood destroying agencies it is intended to combat.
2. It should be of such a nature that it is capable of being absorbed or impregnated into wood.
3. It should possess a high degree of permanence. In order to afford lasting protection, the preservative, once forced into the wood, should not readily evaporate or leach out.

In addition to the above, the following properties are desirable in a wood preservative:—

4. It should not be corrosive to metals, since iron treating equipment is commonly used and metal fastenings and fittings are usually applied to the treated wood.
5. It should have no adverse effect on the strength of wood.
6. It should have no objectionable odour, and, for certain purposes, it should not affect the natural clean appearance of the wood, nor render the surface difficult to paint.
7. It should not increase the inflammability of wood.

8. The price of the preservative should be such as to render its use economically practicable.

A very large number of chemicals and mixtures of chemicals are used as wood preservatives, few, if any, of which meet all the requirements. Those which have been found most suitable and economical for use under South African conditions are as follows:—

Creosote.

Creosote as used for wood preservation is a distillate of coal-tar or coke-oven tar. It is a brown to brownish-black oily liquid with a high boiling point and a characteristic odour. It is a highly complex mixture of various organic substances, and its efficiency cannot be attributed to any one of the constituents in particular. Creosote may vary considerably in quality and should therefore be purchased to certain definite specifications. Its composition has been standardized both by the British Standards Institution and by the American Wood Preservers' Association. The latter specifies a less volatile creosote which is thought to be more suitable for South African conditions.

For efficient preservation under ordinary outdoor conditions, it is necessary to effect an absorption of at least 5lb. (or half a gallon) of creosote per cubic foot of wood for species of eucalypt, while pines require to be impregnated somewhat more heavily.

Creosote is manufactured in South Africa and is obtainable both in drums and in bulk tank trucks.

Fuel Oil.

Fuel oil has no toxic value against fungi. Its value as a preservative comes from its tendency to waterproof wood and thus keep it below the moisture content required for the action of fungi. It is also thought to act as a deterrent against excessive splitting. A profitable use for fuel oil, however, exists in diluting toxic preservatives, e.g. creosote. The crude oil, in the case of a creosote-crude oil mixture, is used as a diluent for the sake of economy, and the mixture should not contain less than 60 per cent. creosote. The treatment recommended is the same as that for creosote by itself.

Zinc Chloride.

Zinc chloride is a water soluble salt and for treatment of timber is used in water solutions up to 5 per cent. in strength. It requires a minimum of ½lb. of dry salt per cubic foot of wood to protect timber efficiently from decay. The strength of the solution required is determined by the amount of the solution the timber will absorb.

The chief disadvantage in the use of Zinc chloride in protecting wood from decay is its solubility in water, which makes its use inadvisable in very wet localities, where it is apt to leach out. Experience in South Africa has shown it to be effective against borers but comparatively ineffective against termites. Its best use is for the treatment of poles for the superstructure of cattle crushes, pergolas, sheds, etc., not in contact with the ground. A useful and economical combination is that in which a pole is treated for its

full length in Zinc chloride and butt treated in creosote for the portion that is to be set in the ground. Zinc chloride is imported into South Africa in drums in the form of the dry salt.

Zinc Chloride and Arsenious Oxide

In order to improve the effectiveness of Zinc chloride treatments against termites, it has been used in mixture with arsenious oxide. The mixtures used at present consist of 1 per cent. Arsenious oxide and 3 per cent. Zinc chloride solution in water. This mixture, while lacking the permanence of creosote, has so far been found to be very effective against termites, borers, and decay.

Other Salts.

Zinc sulphate has a certain value as a wood preservative against decay. It is used to a large extent for the treatment of mining timbers in the Witwatersrand area, where the salt is obtained as a cheap by-product of the gold extraction process.

A number of proprietory compounds, both organic and inorganic, have certain merits as wood preservatives.

V. Preparation of Poles for Preservative Treatment.

Cutting Season.

Satisfactory service can only be obtained from treated wood if it is handled correctly through the entire process. Beginning with the standing tree, the first important question to decide is the time of the year in which felling should take place. It has not been established that the time of cutting has any appreciable affect upon the inherent durability of timber, provided it is properly cared for after cutting. Damage by borers and decay can be done to the poles while they are drying prior to treating. The best time for cutting and drying of the poles will be during the winter when these destructive agencies are least active.

Barking.

As soon as the tree is felled the next question is the proper treatment of the pole obtained. It is not advisable to cut the felled tree to the exact length of the required pole immediately. This is best done after the pole is dry, when badly cracked ends can be trimmed off. Bark is impervious to liquids and should therefore be entirely removed. It comes off more easily while the poles are green and should therefore be removed as soon after the poles are felled as possible. To remove the bark the Department has developed a simple type of barking tool which can be made by any blacksmith. A piece of 1-inch iron of circular cross-section is bunched and flattened at one end to give an edge 3½ inches wide and then ground to a blunt cutting angle with the edge slightly concave to fit the shape of the poles. For gums a heavier type is used than for pines. The cost of the instrument is about five shillings. If only a small number of poles is involved, use can be quite successfully made of a spade or an axe.

The rate of drying of the poles is considerably increased by the removal of the bark.

Seasoning.

As a general rule, and more especially in the case of preservatives of an oily nature, it can be stated that air dry wood will absorb preservatives with greater facility than green wood, and it is therefore important, if the best results are to be obtained, that poles should be sufficiently dry before treatment. Where complete penetration of the wood is impossible, the efficient treatment of the outer layers, which will then form a protective sheath round the pole as a whole, is aimed at. Wood which is not air dry will tend to split after treatment, and in this way the untreated core of the wood may become exposed.

After the trees have been cut and barked, they should be stacked in such a manner that the air can circulate freely about them. The bottom row of poles should be well off the ground and successive rows should be separated by "stickers" as shown in photograph No. 3. Careful stacking will also ensure that the poles remain as straight as possible.

If the necessary apparatus is available for the determination of moisture contents, these should be determined weekly towards the end of the drying period. The best average figure for the moisture content is obtained by taking borings right through the pole some distance from the end. The following figures are given as a general guide to those who do not have the facilities for moisture content determinations :—

Pine poles, 3 to 5 inches in diameter will usually dry out sufficiently in from 4 to 6 months : gum and wattle poles of the same dimensions will take from 6 to 9 months.

VI. Treating Processes Used in Wood Preservation.

The large number of processes used for the preservation of wood can be conveniently divided into two classes (a) Superficial processes and (b) Impregnating processes.

A. Superficial Processes.

The superficial processes refer to those methods of treatment which aim to protect the wood by giving it a mere surface covering. If it were possible to maintain this protective cover, it would effect good protection to sound timber. It is, however, liable to be broken by checking and abrasion, and the effect of the protective shell may be entirely lost. The sound outward appearance may then mask a rotten interior. Again, if wood which is not quite sound, i.e. containing incipient decay, is treated superficially, the decay may continue to grow and in due course render the wood useless. Where the surface of sound wood, however, is not subject to abrasion or checking, these treatments have considerable value. They are cheap and easily conducted and are of special usefulness where only a small amount of timber is to be treated and for treatment of timber on the job.

Brush Treatment.

Brush treatment consists of applying the preservative, usually oil or paint, to the surface of the wood by means of a brush. The best results are obtained on seasoned wood. The oils recommended are creosote and carbolineum and they require to be applied hot to obtain the greatest benefit. Penetration in any case is usually very poor and great care should be exercised to cover all cracks, splits and joints in the woodwork. Three coats of the hot preservative should be applied to the wood. The first coat is allowed to dry for at least 24 hours before the second coat is applied, and the last coat is given just before the timber is placed.

Satisfactory results may be obtained if the preservative is carefully applied. If, however, proper precautions are not taken the treatment is quite ineffective.

Brush treatment has its advantages in so far as no expensive plant is required and the preservative is easily applied. It is especially adapted for treating poles on farms in inaccessible parts and also for treating structural timbers on the job.

Dipping.

Dipping is more effective than brush treating as the preservative enters all the splits and crevices in the wood and there is greater certainty that the entire surface of the wood is treated. A tank of sufficient size to submerge the timber is required.

Dipping in preservatives is used extensively to prevent blue stain in sawn timbers where the original colour of the wood in the final product must be maintained, e.g. box shooks.

Spraying.

Preservatives can be sprayed on to the wood by means of a pump. Here again, better penetration into checks and cracks can be obtained and a more efficient covering of the surface of the wood than with brush treatment. Spraying is especially useful for treating poles already in service, which show signs of decay or termite attack.

The superficial processes must be considered as very inferior to a thorough impregnation with the preservative and should only be resorted to where, due to the extra expense or inconvenience, the use of one of the impregnating processes is not justified.

B. Impregnation Processes.

The impregnation processes aim at forcing the preservative deep into the wood, to get complete penetration of the pole, or, if that is not possible, at least complete penetration of the sapwood, and thus minimise the chances of any untreated wood becoming exposed when the surface of the wood is damaged in service. On account of the greater amount of preservative present under these processes leaching and evaporation from treated wood are of less importance. These processes are therefore considerably more efficient than the superficial processes. The actual depth of penetration obtained will depend on the species of wood and the particular process employed.

Impregnation processes are more expensive than superficial processes and require more elaborate apparatus. They can be divided into two classes :—

(a) Pressure processes in which artificial pressures higher than that of the atmosphere are employed; and

(b) Non pressure processes in which use is made of the expansion and contraction of air in the wood on heating and cooling.

Pressure Processes.

It is intended to give only a very brief resume of these processes here.

The treatments are carried out in closed steel cylinders and pressure up to 200lb. per square inch and temperatures of up to 200°F. are employed. The pressure is obtained either by means of liquid force pumps or compressed air, while heating is carried out by means of steam coils.

If a vacuum is first drawn on the charge in the cylinder, the preservative run in, and the pressure raised subsequently, the preservative is made to fill the cell cavities. This is known as the full cell treatment. If, on the other hand, the charge is subjected to an initial air pressure, the preservative forced in against this pressure, and the pressure on the liquid raised subsequently, impregnation affects mainly the cell walls. This is known as the empty cell treatment. The initial air pressure in this case may be either that of the atmosphere alone, or may be raised to any pre-determined figure by an air compressor. Most of the liquid in the cell cavities is forced out by the expansion of the compressed air in the wood on release of the pressure.

The choice between the two treatments depends on the kind of wood and the purpose for which it is to be used. The absorption in the full cell treatment is much heavier than in the empty cell treatment for the same penetration.

In general the best results are obtained by means of the pressure processes. The plant required is expensive and the cost of its installation is only justified for large scale operations.

Non Pressure Processes.

The non pressure processes rely on the absorptive properties of the material to draw the preservative into the wood. The plant, which is much cheaper than that of the pressure processes, consists of open vats or tanks with suitable arrangement for heating the preservative.

The Steeping Process.

The steeping process, which is usually employed with metallic salt solutions only, consists simply of submerging the poles for a few days in a tank of unheated preservative. Care must be taken that the poles are submerged for the whole period, and the tanks may be covered to reduce evaporation to a minimum. The only plant required is an open tank, large enough to take the material to be treated. If a cattle dip is available on a farm, it should be quite suitable for the purpose.

The amount of preservative absorbed and the penetration depends on the species of wood treated. Sufficient absorption can normally be obtained in two days with pine, but gums need a somewhat longer period.

Open Tank Process.

The process derives its name from the nature of the plant used, which consists of an open tank with suitable means for heating. Where steam is available the heating of the preservative is done by means of steam coils, whereas in small farmers' plants the heating is usually carried out by means of an open fire. The poles are placed in the open tank and submerged in the preservative which is heated to from 150°F. to 220°F., the maximum temperature being maintained for from 1 to 4 hours. The poles are now either allowed to cool in the tank down to atmospheric temperature, or may be removed and immediately transferred to a second tank containing cold preservative and left for a few hours to cool.

The principle made use of is that during the hot period the air in the cell cavities expands and partially escapes, and on cooling what is left contracts and draws the preservative into the wood. An overhead travelling gantry or suitable shearlegs and tackle is usually installed to facilitate the charging of the tank with poles.

Photograph No. 4 shows a steel open tank, the actual dimensions of which are adapted to the size of the material it is required to treat. The tank can either be of rivetted or welded construction and is usually made of mild steel plate. Angle iron ribs strengthen it at intervals along the length. It is heated by means of 1-inch diameter steam pipes running along the bottom for its full length. The pipes are passed through mild steel bars, the upper edge of which takes the weight of the poles and prevents damage to the pipes. A steam trap is provided to dispose of condensation from the coil.

A tank of this nature is suitable as a permanent installation where steam is available. Equipment of simple construction, suitable for operation on the farm, is described in the following section.

Farmers' Treating Plants.

The amount of money that can be economically spent on the construction of a plant for the preservation of timber on a farm depends on the quantity of timber to be treated. This quantity is usually comparatively small so that the cost of the plant should be correspondingly low. The plant must be of such a nature that creosote may be heated with safety over an open fire. Though creosote is inflammable, the exercise of care to prevent it from boiling over into the fire or splashing over when the poles are put in, will minimise the danger from fire.

Many different types of farmers' plants have been evolved. A common method is to use a 90 gallon drum erected over a temporary brick fire place, usually with a length of piping to secure a good draught. One of the best methods of erecting this type of plant is to sink the drum, which measures about 3 feet 6 inches in height,

to about two-thirds of its length into the ground, which facilitates the placing of the poles in the drum, and enables the heating to be carried out very economically and safely. Figure i gives the details of the construction of this plant.

A 90-gallon drum is suitable for the full length treatment of short poles up to about 6 feet. First one half of the pole is treated and the pole is then inverted for the treatment of the other half. Instead of inverting the poles and treating them full length, good protection can be obtained by treating the butts fully and merely dipping the remainder of the pole in hot creosote. The most vulnerable part of the pole being that which goes into the ground, this is thoroughly protected by the butt treatment.

The plant is best erected under the roof of a shed with open sides. This enables work to be carried out under all weather conditions and prevents rain from falling into the drum and water from filling the pit.

If longer poles are to be treated a horizontal open tank is required, the size of which will be governed by the size of the poles to be treated.

A plant which has been found to give very satisfactory service is that shown in Figure ii. The tank should be made of 14 gauge galvanised, flat sheet iron. The joints are welded and the tank is built in with brick walls as shown. The bricks should be placed tightly against the sides so that the flames are kept down to the lower curved portion of the tank. The tank should be supported, at both ends and in the centre, by brick walls built to conform to the shape of the bottom of the tank. The equipment should be placed under a shed for protection from rain or a few galvanised corrugated iron sheets should be kept available to cover it during rainy weather.

Operation of the Farmers' Plant.

The preservative in the tank is heated to a temperature of from 150°F. to 220°F. While it is heating up, the poles are placed in the tank and weighted down by means of any suitable weights that are available, such as blocks of concrete, steel rails or a drum filled with water. A thermometer is used to register the temperature and the preservative should be kept at the maximum temperature for one to four hours depending on the diameters and species of the poles. The fire should then be drawn and the preservative with the poles still submerged should be allowed to cool down to about atmospheric temperature. As most of the absorption takes place during the cooling period, and the level of the liquid is lowered during this time, care should be taken that the poles are not removed too soon and that they remain covered for the whole period.

The best procedure is to treat only one batch of poles per day. Fill the tank with poles during the morning, heat it up to the required temperature, allow it to cool overnight, remove the poles the next morning and then repeat the process with a fresh batch of poles.

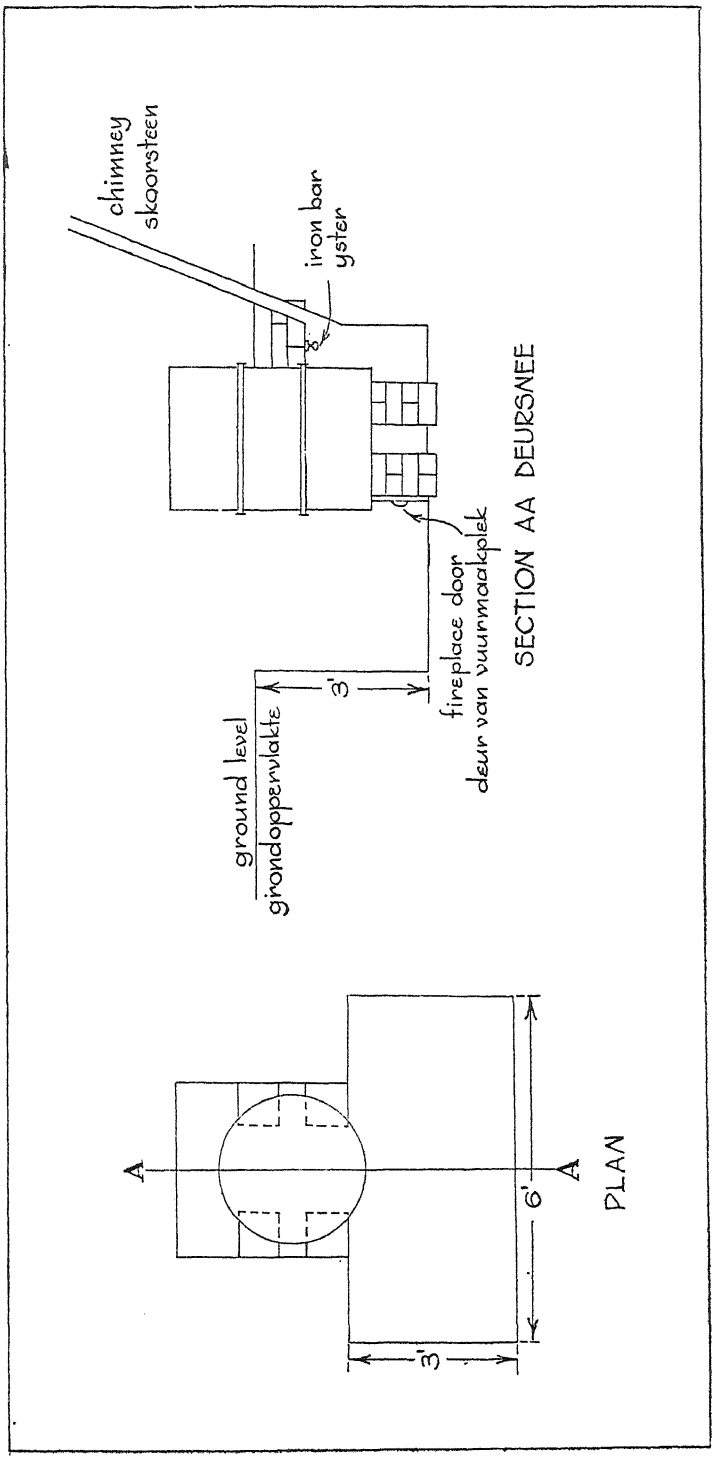


FIG. 1.—Ninety gallon drum suitable for treating fence posts.

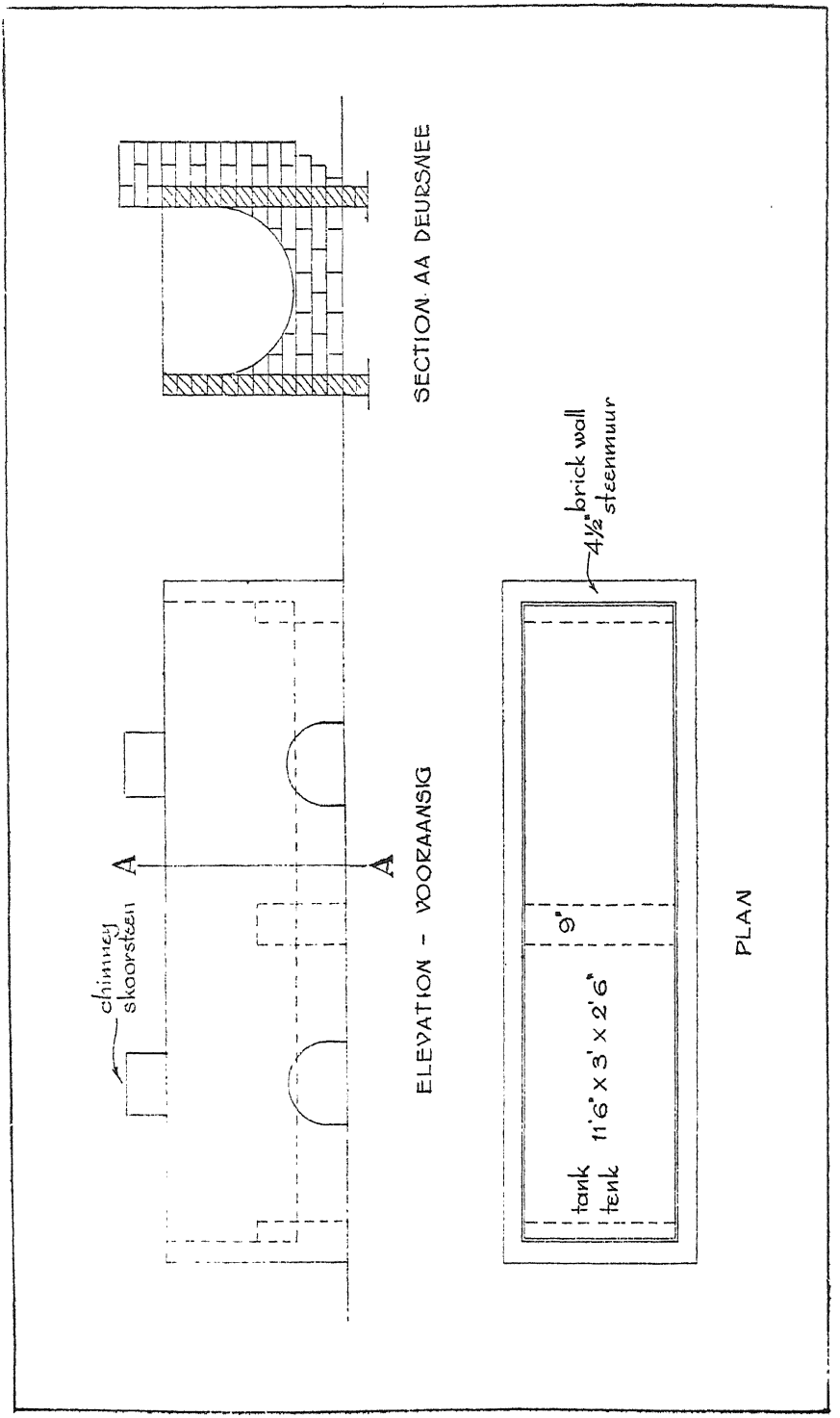


FIG. ii.—Open Tank suitable for farm use.

The approximate absorption, which should range from half a gallon per cubic foot as stated previously, can be checked by weighing a few sample poles before and after treatment, the volume of the sample poles being obtained by measuring their length and average diameter.

It may happen with the above procedure that the absorption is excessive, i.e. above the maximum of one gallon or 10lb. per cubic foot, especially in the case of young pine poles, and this tends to make the treatment unnecessarily expensive. Absorption can be decreased by employing a lower maximum temperature or reducing the time the poles are kept at the maximum temperature.

Penetration can best be gauged by sawing a length of about one foot from the centre of a pole and splitting this along the grain with an axe.

Difficulty in obtaining satisfactory penetration with gum or pine poles may be due to the poles being too wet or incompletely barked or failure to attain a high enough temperature for the preservative and to maintain the maximum temperature sufficiently long, or the removal of the poles before the liquid is cold.

To facilitate the loading of the poles into the tank and also removal after treatment, shearlegs and a block and tackle should be used, as shewn in Photograph No. 5. A trek chain is used to bundle the poles and is only released but not removed during treatment. To remove the load the trek chain is simply hooked to the block and the poles hoisted from the preservative. On removal the charge should be allowed to hang over the tank for about half an hour, to allow the drip from the surface of the poles to fall back into the tank.

VII. Durability of Untreated Wood.

Wood, as we have seen, is subject to attack by certain destructive agencies, and if these could be permanently excluded, the wood substance would be very nearly ever-lasting. Certain woods have inherent characteristics which give them the power of resisting such agencies to a marked degree and these are said to possess natural durability. The durability in any instance is dependent on the degree of suitability of the conditions for the activity of fungi, termites, borers and the like, and the degree of intensity of the influences which tend to break down the natural resistance of the wood.

Sapwood is non durable regardless of the species of the tree from which it is obtained. The durability of the heartwood on the other hand varies considerably with the species. Since 1921 experiments on the natural durability of the heartwood of the more common indigenous and exotic trees have been carried out, the results of which are reflected in Table I and Table II. The heart wood of those species which withstood the ravages of termites and decay for a period of six years and longer is considered as durable, while all others are considered as "non-durable."

VIII. Durability of Treated Wood.

The durability of wood treated with preservatives is determined by the following factors:—

1. The efficacy of the preservatives, with more particular reference to its protective and lasting qualities.
2. The amount of the preservative present in the wood. For a given absorption, the greater the penetration the more effectual is the treatment. All types of wood are not equally amenable to treatment with preservatives, and the durability of the preserved wood is therefore indirectly dependent upon the species.

   Other things being equal, the absorptive power of wood is dependent very largely on its density—that is, the relative volume of the cell cavities which are capable of being filled with preservative. The wood of heavy gum species will therefore not absorb as much preservative as the less dense pines. It has been found that, on account of inherent peculiarities, the heartwood of gums and other hardwoods and both the heartwood and sapwood of cypress are not amenable to preservative treatment.
3. The conditions under which the wood is placed in so far as they affect the activity of the inimical agencies and the stability of the preservative in the wood.

Results obtained from service tests have shown that under average South African conditions the probable life of poles treated in zinc chloride and placed in ground not infested with termites, is from 6 to 12 years. The addition of arsenious oxide to the zinc chloride increases the effectiveness of the treatment against the attack of termites and a similar service life may be expected.

Where the metallic salt treated timbers are not exposed to outdoor conditions or to the attack of termites, as in the case of rafters, floor joists, etc., the timber retains the preservative practically indefinitely and becomes to all intents and purposes everlasting.

Service tests with poles treated in creosote and creosote-fuel oil mixture, show the soundness of the poles unimpaired after 15 years. Judging from results obtained in other countries a life of 20 years and more can be expected from thoroughly creosote treated timber, under the most adverse conditions.

IX. Protection of Interior Wood-Work.

The moisture content of properly seasoned interior wood-work is normally below the limit required for the existence of wood-rotting fungi and such wood is consequently immune against these destructive agencies. Wood is, however, to a certain extent hygroscopic and tends to take up moisture from the air as atmospheric humidity increases and to lose moisture during periods of dry weather. This variation in moisture content of the wood is accompanied by corresponding swelling and shrinkage, which, again, may cause warping, opening of checks, weathering and the like. A certain amount of protection against such

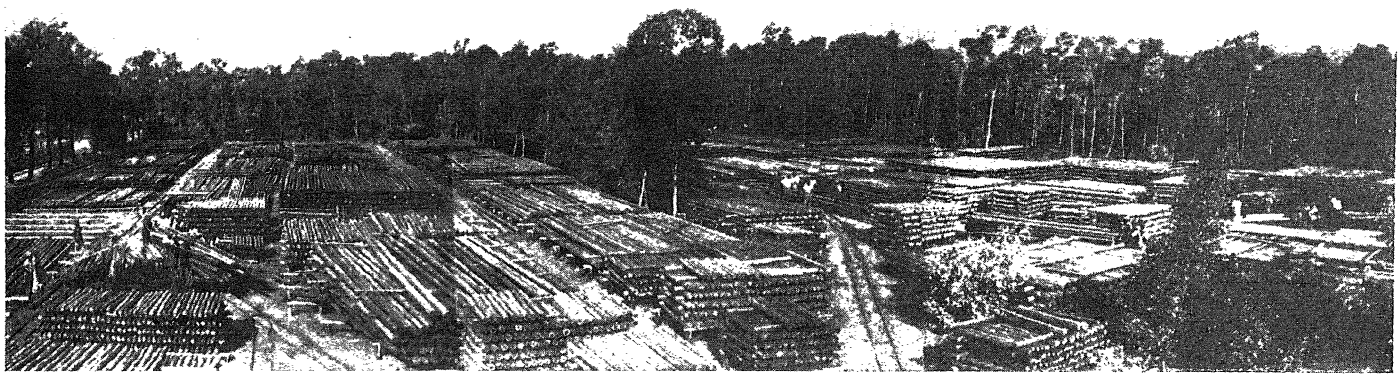


PHOTO 1.—Pole Seasoning Yard, Forest Products Institute, Pretoria.

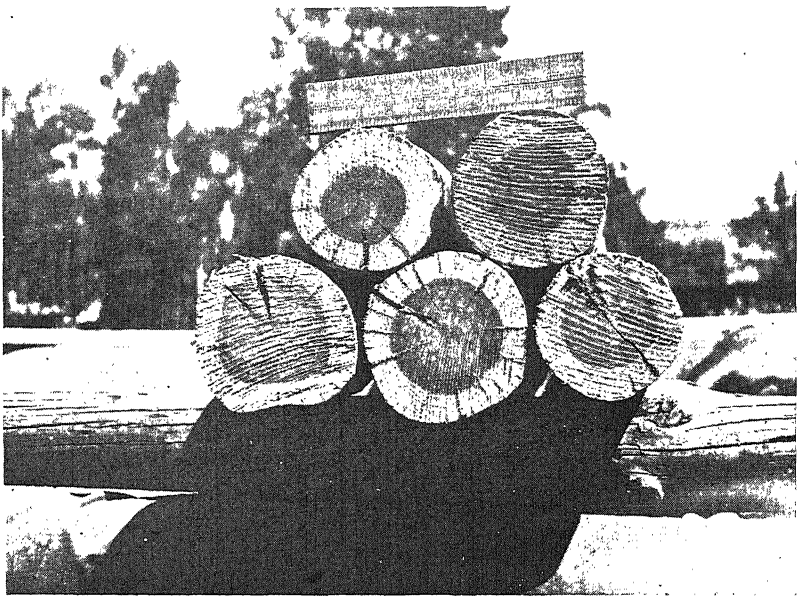


PHOTO 2.—Cross-section of Poles; showing contrast between heartwood and sapwood.

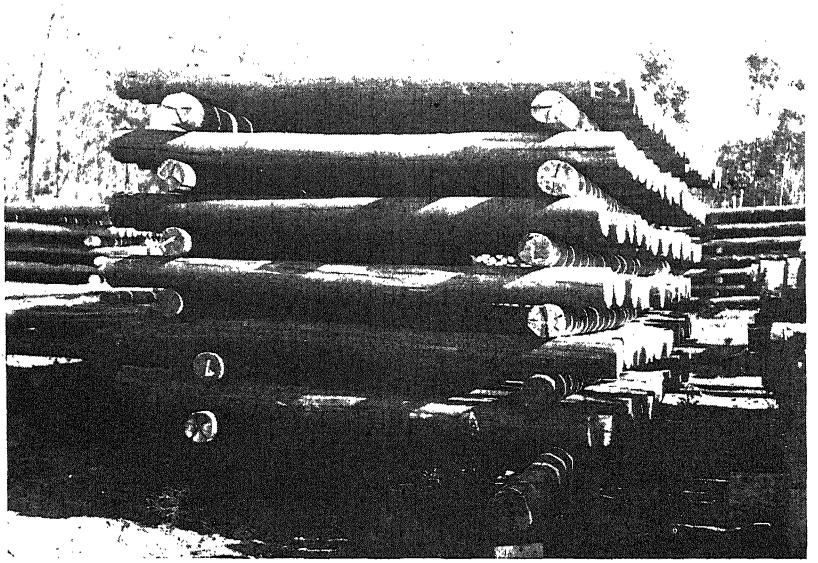


PHOTO 3.—Correct method of stacking poles for air seasoning.

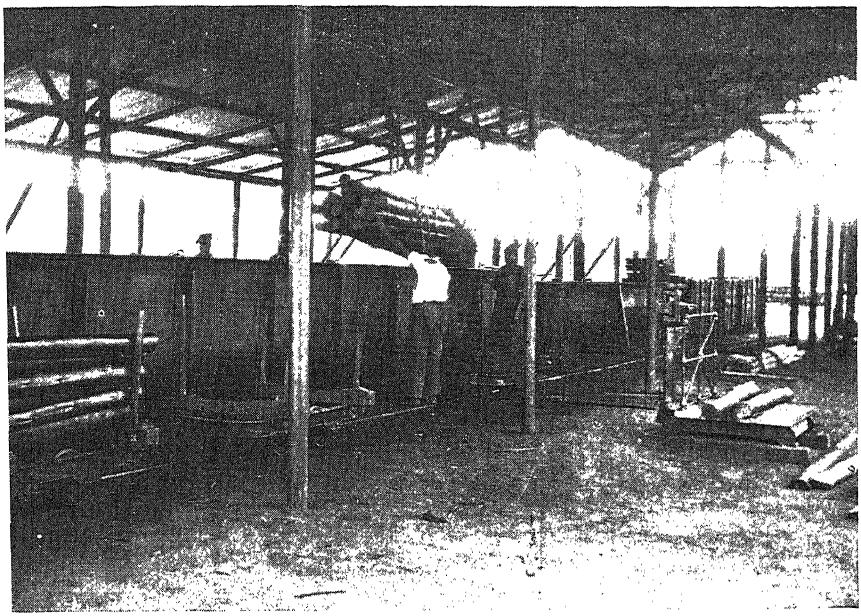


PHOTO 4.—Open Treatment Tanks at Forest Products Institute. Left to right: 36 and 30 foot steel tanks, and 30 foot wooden tank. Removal of charge by means of overhead gantry. On right, scale for weighing sample poles. Trucks in foreground.

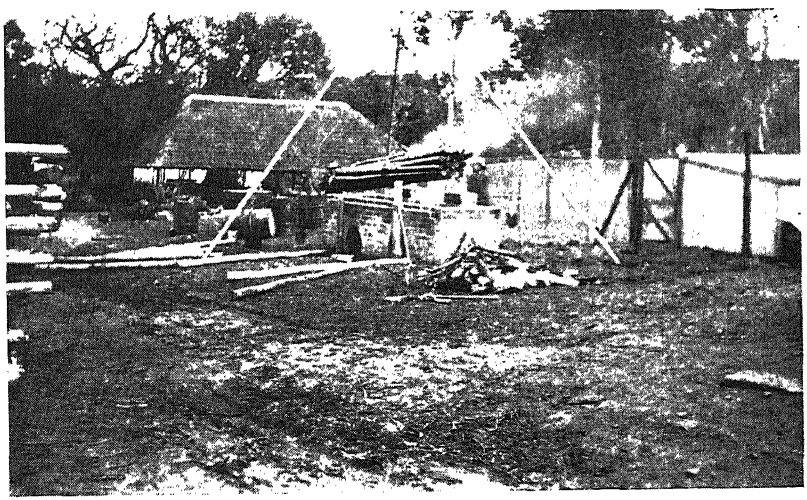


PHOTO 5.—Charging a farm treatment tank with shear-legs and block and tackle.

TABLE I.

INDIGENOUS SPECIES.

Botanical Name	Common Name
DURABLE.	
Acacia pallens	Knoppiesdoring
Faurea Macnaughtonii	Terblans
Ptaeroxylon obliquum	Sneezewood
Pterocarpus angolensis	Kiaat
Pygeum africanum	Red Stinkwood
Spirostachys africanus	Tambootie
Strychnos Henningsii	Hard Pear
Widdringtonia juniperoides	Clanwilliam Cedar
NON-DURABLE.	
Adina Galpini	Matumi
Albizzia gummifera	Flatcrown
Albizzia versicolor	Umvanghaas
Apodytes dimidiata	White Pear
Bersama Stayneri	Bersama
Brachylaena sp.	Vaalbos
Burkea africana	Wilde Sering
Buxus Macowani	Buig-my-nie
Calodendron capensis	Wild Chestnut
Canthium obovatum	———
Cassine croceum	Saffraan
Celtis Kraussiana	Camdeboo Stinkwood
Combretum Kraussii	Rooiblad
Croton sylvaticus	Croton
Cryptocarya transvaalensis	Wild Quince
Cryptocarya vaccinifolia	———
Cunonia capensis	Rooi-els
Curtisia faginea	Assegai
Diospyros mespiliformis	Jakhalsbessie
Ekebergia capensis	Essenhout
Fagara capensis	Knobwood
Gonioma kamassi	Kamassi
Ilex mitis	Without
Kiggelaria africana	Wild Peach
Kirkia acuminata	Wit sering
Lachnopylis floribunda	Vlier
Milletia caffra	Umzimbeet
Ochna arborea	Cape Plane
Ocotea bullata	Black Stinkwood
Olea laurifolia	Black Ironwood
Olinia cymosa	Hard Pear
Platylophus trifoliatus	Wit-els
Podocarpus sp.	Yellowwood
Pterocelastrus tricuspidatus	Kershout
Rapanea melanophleos	Boekenhout

INDIGENOUS SPECIES

Botanical Name	Common Name
NON-DURABLE.	
Royena lucida	Swartbas
Sclerocarya caffra	Maroela
Scolopia Mundtii	Red Pear
Scolopia Zeyheri	———
Trichelia emetica	———
Trema bracteolata	Pigeon wood
Vepris lanceolata	White Ironwood
Virgilia capensis	Keur
Xymalos monospora	Lemonwood

TABLE II.

EXOTIC SPECIES.

DURABLE.

Eucalyptus Blakelyi	Eucalyptus polyanthemos
,, citriodora	,, rostrata
,, paniculata	,, sideroxylon
,, piperita	,, tereticornis

NON-DURABLE.

Acacia melanoxylon	Eucalyptus microcorys
,, mollissima	,, obliqua
Araucaria Cookii	,, ovata
Callitris robusta	,, numerosa
Castanea sativa	,, pilularis
Casuarina Cunninghamiana	,, radiata
Cedrela odorata	,, regnans
Cedrela toona	,, resinifera
Cedrus deodara	,, robusta
Cinnamomum camphora	,, saligna
Cryptomeria japonica	,, Sieberiana
Cupressus lusitanica	,, viminalis
,, sempervirens	,, yarraensis
,, torulosa	Grevillea robusta
Eucalyptus altior	Jacaranda mimosaefolia
,, botryoides	Melia azedarach
,, cornuta	Pinus canariensis
,, diversicolor	,, halepensis
,, eugenioides	,, insignis
,, fastigata	,, longifolia
,, gigantea	,, patula
,, globulus	,, pinaster
,, gomphocephala	,, taeda
,, grandis	,, teocote
,, Macarthuri	Populus canescens
,, macrorrhyncha	Quercus pedunculata
,, maculata	Syncarpia laurifolia
,, Maideni	

"working" or "movement" of wood may be brought about by the application of moisture retardant finishes, such as paint, oil, varnish or wax, the use of which is advocated for all classes of interior woodwork. None of these coatings are, however, completely moisture proof.

It is often found, in the case of furniture, fittings and ornaments made of hardwoods, that the sapwood is attacked by the larvae of wood boring beetles. As it is usually out of the question to subject articles of this nature to a full preservative treatment, their protection is a matter of some difficulty. If the damage is not too extensive the most practical method is to inject a solution of equal parts of paraffin and turpentine into all the flight holes. This can be accomplished by means of a large hypodermic syringe, the needle of which is pierced through a rubber stopper so that it projects about one-eighth of an inch. The needle is placed in the flight hole, the rubber pressed against the wood and as much liquid as possible forced in.

The likelihood of attack by wood boring beetles is considerably reduced if the wood is thoroughly coated with materials such as varnish and French Polish. Such coverings, are, however, powerless to check this form of damage once the larvae are present in the wood.

Economics of Wood Preservation.

When a non-durable wood, to be used in a permanent location, is given a preservative treatment by which its durability is considerably increased, the treatment usually results in a great saving of money. If the average life and the cost in place of treated and untreated wood are known, the relative annual cost of each can be calculated, using the formula :—

$$A = \frac{P\,(1 + r)^n\, r}{(1 + r)^n - 1}$$

Where A = Annual charge
P = Amount of initial investment
r = The rate of interest expressed decimally
n = The average life of the timber.

It is found, for example, that the average life of an untreated pole in South Africa is approximately three years and costs in place about 1s. per cubic foot. Taking interest at 5 per cent. the annual maintenance, using the above formula, comes to 4.2d.

A similar pole treated in creosote costs in place about 2s. 6d. per cubic foot, and has an average life of approximately 20 years. The annual maintenance charge in this case comes to 2.4d. and shows a considerable saving.

Knowing the life of treated and untreated timber and the cost of untreated timber, the timber user can calculate the amount he can spend on treatment to make the treated timber as cheap as the untreated. Taking the figures used in the previous paragraph, the amount that can be paid for creosote treated wood is given as 4s. 3d. per cubic foot.

The minimum life for creosoted wood costing 2s. 6d. in place, to be just as cheap as untreated wood costing 1s., is given by the above formula as 9 years.

When wood is used where only a short life is required, there is obviously no advantage in preservative treatment, and treatment of naturally durable timber usually does not mean a saving. Preservative treatment, however, may make it possible to substitute for the naturally durable timber an inferior, non durable, treated timber with a life as long or longer. Besides the actual maintenance cost, there are other factors that should be considered. By lengthening the life of timber and permitting the use of low grade material, preservation helps to conserve timber supplies. Where wood preservation is not practised, durability of timber is of great practical moment and many species are classed as inferior mainly because of lack of durability.

Forest management is influenced by such considerations in so far as in the selection of species for afforestation, durability is not necessarily a factor to be considered, provided the wood is amenable to preservative treatment.

A PRELIMINARY REPORT ON SOME ASPECTS OF WATTLE PATHOLOGY.

By R. P. STEPHENS (*Forest Research Officer, Pietermaritzburg*) and W. B. GOLDSCHMIDT (*School of Agriculture, Cedara*)

This paper was read before the South African Association for the Advancement of Science at Pietermaritzburg, July, 1938.

THE term *pathology* is here used in its widest sense so as to include conditions due not only directly to bacteria, fungi or viruses, but also to physiological upsets resulting from such causes as insect attacks or from undetermined causes. The wattle species dealt with are Black (*Acacia mollissima* Willd.) and Green Wattle (*A. decurrens* Willd.). As stated by Robertson (8) these species are indigenous to certain portions of the cool-rainfall areas of Australia, and have been planted (the former extensively) at elevations of from 2,000 to 5,000 feet in the summer rainfall areas of eastern South Africa.

Wattle bark is a most valuable tanning material. The production, harvesting and export of bark and bark extract form an industry of major local importance, while the wood yielded is consumed in large quantities as fuel or mining timber. It is a matter of interest that 30 years ago the annual value of bark exported and wood consumed locally was approximately £100,000. To-day it probably exceeds £1,500,000; yet during the past twenty years, two short popular articles by Ripley (7) are the only publications on any aspect of wattle pathology that have appeared. In fact, according to Williams (11), this subject is one which has received very little attention anywhere in the world.

The reason for this apparent apathy locally is not that wattle plantations have been free from disease in the past, but that other problems such as wattle bagworm and silviculture have claimed prior attention. The need for research has now become intensified, however, because under modern silvicultural technique the number of trees maintained per acre has been considerably reduced. This has been done in order to render the production of bark more economic, and to raise its quality to that required by the overseas market. Factors causing tree mortality and bark loss, previously relatively unimportant, have suddenly assumed special significance, and it has become necessary to find economical ways and means of reducing the resulting losses.

The object of this paper, therefore, is to summarise the existing knowledge about these diseases and to discuss the lines along which research is proceeding in an effort to find ways of checking their ravages.

GUMMOSIS.

Importance.

From an economic point of view gummosis and the damage caused by the insects already referred to, are the most serious of the diseases to be described.

Bark which is badly affected by gummosis is not saleable and has to be discarded, while plantations which are badly diseased have often to be felled before their normal rotation age, as the disease almost invariably becomes worse with increasing age. In many cases, trees are killed outright by it. In other cases, due to gummosis, it is not possible to remove the bark for three years or more. In these ways not only is plantation management upset, but bark yield per unit area is actually lost. At the present market price of bark, the loss to the industry runs into many thousands of pounds per annum. This loss, unfortunately, is not spread evenly over all areas, but is concentrated more in certain localities than others. An important point, however, is that where gummosis does occur it is usually fairly evenly distributed throughout the stand, a percentage of the trees always being free from gummosis.

Morphology.

As shown by van der Byl (9), gummosis commences by breaking down the phloem tissue in the bark, about halfway between the cambium and the periderm. These areas appear as blackish depressions from which often there is a copious exudation of gum, and the general impression is one either of mottling, which may extend many feet up the bole of the tree, or of tree butts discoloured by the presence of large black cracked patches which may gradually encircle the tree and extend up its bole for a long distance (see Figs. 1-3).

In many cases recovery or partial recovery does take place, but usually any secondary meristem which is formed by the plant in an effort to isolate the disease, itself becomes affected and in bad cases the disease spreads inwards to the cambium, eventually killing the tree.

History and Distribution.

According to van der Byl the disease has been known in Natal since about 1908 or 1909, but Mr. J. J. Boocock, until recently Conservator of Forests for Natal, Zululand, and the Orange Free State, informs us that gummosis was observed in the Eastern Cape Province several years earlier. In view of the occurrence of gummosis to-day in first rotation crops and in isolated patches of wattle, there seems no reason to believe that it has not always occured in wattle plantations in this country. It occurs to-day on all types of sites and under all kinds of conditions. Soil types varying from sands to heavy clays, depths varying from a few inches to many feet, and geological formations, whether igneous or sedimentary, appear to have little influence upon its occurrence.

There is unquestionably a marked correlation between the incidence of the disease and soil moisture, though cases do occur over a wide range in rainfall. On the moister soils there is, in general, a marked increase in the amount of gummosis present. Particularly is this the case where the soil is of a sandy nature, as, for example, at Melmoth, Kranskop and Paddock. Yet, on the other hand, cases have been noticed where the trees in valleys were healthy, while the trees on the drier ridges in the immediate vicinity, were badly diseased.

It is often said by wattle growers that where plantations have been established on sites where natives have herded their cattle for long periods, gummosis is invariably much worse. While this observation may be true in general, exceptions do occur and severe attacks of the disease are not necessarily confined to old kraal sites.

Gummosis has occasionally been attributed to heavy applications of superphosphate. This view does not appear to be valid, however, for gummosis is no worse on shale and doleritic soils, which have a high available phosphatic content, than on sandy soils where this constituent is low. Where heavy applications of superphosphate are given to sample plots, moreover, the disease is no worse and often not as marked as in the less heavily fertilised controls.

The Health and Age of Susceptible Trees.

The health and vigour of trees do not appear to be factors which can be correlated with the incidence of gummosis. It is maintained by many growers that in plantations of heavily branched trees, due to drastic thinnings, gummosis is usually worst. In other words, they maintain that the higher the vigour of the tree, the worse the incidence of gummosis. Where, however, it does happen that heavily branched plantations are suffering severely from gummosis, this can often be attributed to causes other than the vigour of the trees. In comparable plots in which vigour as judged by the number of leaves per tree has been deliberately varied by maintaining stockings per acre ranging from 100 to 3,000 for four years, there are to-day no significant differences in the amounts of gummosis present. Per tree of course, there is more gum exuded with the lower stockings than with the higher, but per acre probably much less. Jungle plantations, namely plantations started with 10,000 to 20,000 trees per acre and left unthinned until the second or third years, appear less susceptible than better managed plantations, but such plantations are, of course, uneconomic.

Gummosis may appear in trees of any age from a few months to many years, but the most usual stage is from 2½ to 5 years.

Causes and General Discussion.

The primary cause of gummosis in wattles is unknown. No causal organism has as yet been found to be associated with it. As far as we are aware, however, only preliminary investigations of the roots of affected trees have hitherto been made. Microscopic examination seems to have been confined to the bark mainly of affected trees. Further investigation of both diseased and disease-free trees is now being initiated.

The possibility of gummosis being due to a virus has been raised and work to examine this question was initiated about a year ago. Unfortunately the officer who would, it was hoped, have been able to carry out this investigation had to abandon it due to the pressure of work which had prior claims on his time. As soon as opportunity permits, however, this line of work will be continued.

One of the main secondary causes of gummosis is without doubt connected with the supply of moisture. Not only is there a tendency for the incidence of gummosis to increase with an increase in the average annual rainfall or soil moisture content, but severe outbreaks of gummosis have often been correlated with periods of heavy rainfall following periods of drought.

Theorising along these lines, it may be suggested that gummosis is a result of the loss of balance between crown and root. Wattles do not easily regain lost foliage, so that defoliations caused by drought or severe suppression would not be replaced immediately, if at all, with the advent of heavy rains. The rate of absorption of moisture and mineral salts might temporarily, therefore, be greater than losses by transpiration and metabolism. In support of this it is to be noted that usually at some stage between the third to the fifth years under normal modern management, marked crown reduction does take place. When this happens there is likely to be a marked upset in the balance between crown and root systems. This is the period during which gummosis usually first makes its appearance. In older suppressed plantations the incidence of gummosis increases during periods of heavy rainfall. This theory is not born out by certain heavily pruned experimental plots in which no positive reaction was observed, although the effect of the pruning may have been masked by a succeeding spell of exceptionally dry weather.

The claim that the incidence of gummosis is higher on old kraal sites, is under consideration. Preliminary investigations suggest that this effect is not associated with either total or available nitrogen in the soil. Samples of soil representing various plantation blocks at Mountain Home, an estate of the Natal Tanning Extract Company, were collected in December, 1937, and the total and available nitrogen constituents determined therefrom. As a control a sample of virgin veld typifying the original nitrogen status of the area was included.

Details of the samples collected are as follows:—

Sample A. Block 28. Under wattle for 26 years (3 rotations). The trees had just been felled prior to sampling. This represents an area in which gummosis was exceptionally bad.

Sample B. Virgin hill-side grassveld in the vicinity of Block 28.

Sample C. Block 27. First wattle planted in 1927. Trees were mature and healthy.

Sample D. Block 22. Under wattle for 26 years. The fourth rotation was started in 1936. Trees were very healthy. The area is rather low lying.

Sample E. As for Block 22, but taken on summit of hill. The trees were very healthy.

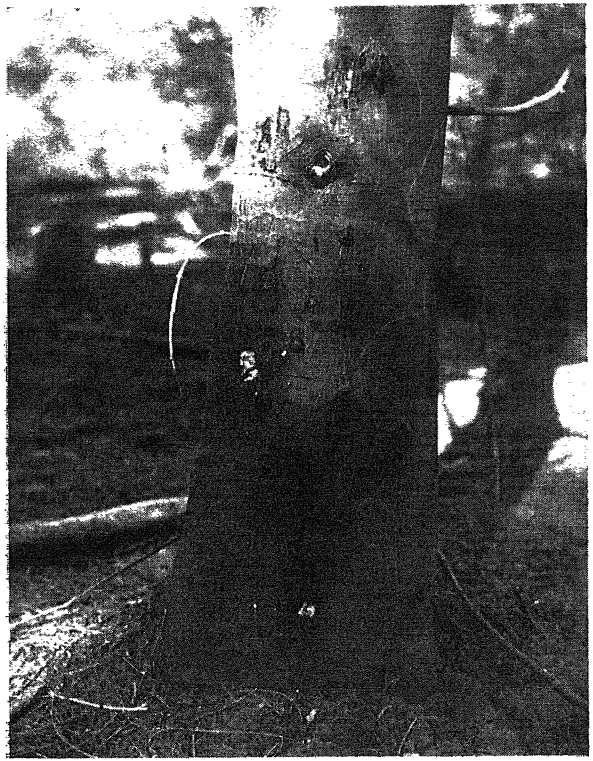


FIG. 1.—ACACIA MOLLISSIMA. WINDY HILL. 1938. Very vigorous, four year old tree showing incipient mottling. One or two of the depressions have burst and gum is exuding.

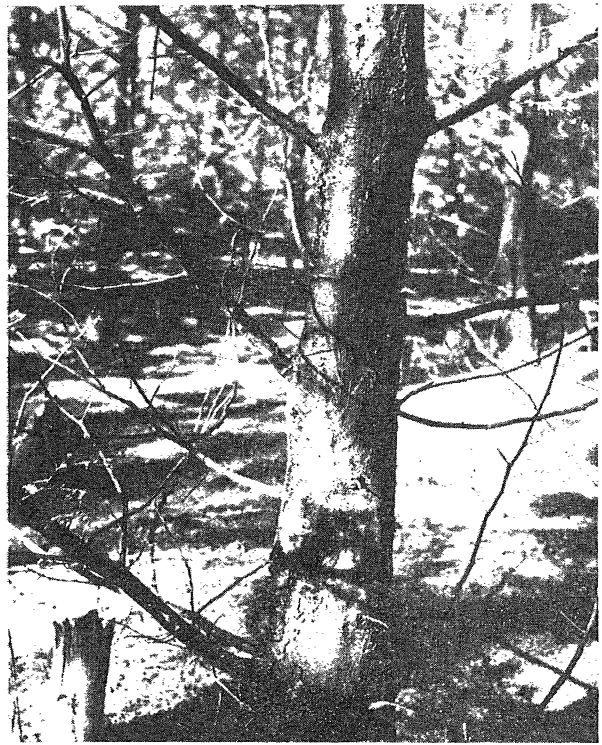


FIG. 2.—ACACIA MOLLISSIMA. WINDY HILL. 1938. Four year old tree. Good thinning, as indicated by the development of strong branches from the base of the tree. The lower branches have all shed their leaves and gummosis is severe.



FIG. 3.—ACACIA MOLLISSIMA. The bark from all the healthy trees in this stand has been marketed. The remaining trees, due to gummosis, will not "strip."

Photo by C. A. Smith.



FIG. 4.—ACACIA MOLLISSIMA. WINDY HILL. The bare grassy patch in the foreground is largely the result of mortality due to the Albert Falls disease and collar rot. Note the large vigorous trees which have died more recently.

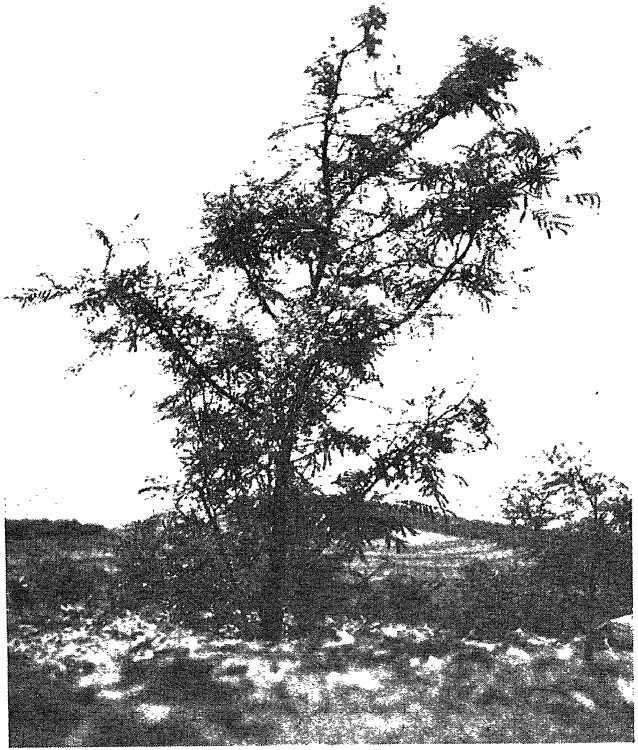


FIG. 5.—ACACIA MOLLISSIMA. Silhouette of tree, four feet high, showing stunted and deformed growth produced by froghopper.

Photo by C. A. Smith.



FIG. 6.—ACACIA MOLLISSIMA. Distorted growth of semi-mature plantation due to attacks of froghopper during youth.

The results as presented in the following table are calculated on oven dry material (100° C.) :—

Sample	Total Nitrogen percentage.	$NH_3N.$ + $NO_3N.$ parts per million.
A.	0.328	15.12
B.	0.263	8.96
C.	0.328	13.72
D.	0.331	31.92
E.	0.323	15.96

These figures indicate that there is apparently no correlation between gummosis and nitrogen content of the soil.

The Albert Falls Disease.

This name is here given to a disease which first caused alarm on two estates in the Albert Falls District.

Importance.

The stands of trees affected were among the first to be treated on the sylvicultural lines recommended by the Forestry Department. The recommendations entail the reduction of the number of trees per acre from several thousands to 200 or 300 by the end of the second or third years. In the case of the stands referred to, the stockings over quite large portions were further reduced by 50 to 60 per cent. due to mortality from this disease. Had the disease become as serious in the rest of the industry as it was in the Albert Falls area, it may have called for a drastic change in sylvicultural policy, and it would have been a most serious menace to the future of the industry. Nowhere else, fortunately, has it caused the same high percentage of mortality, but, nevertheless, its presence remains a constant danger which, on account of its virulence, will have to be very carefully watched (see Fig. 4).

Apart from the actual mortality losses, the disease is serious because the dying trees form ideal breeding grounds for two cerambycids, *Ceroplesis thunbergii* and *Pycnopsis brachyptera.* These feed on the bark and wood of young shoots, including generally the leading shoots, causing them to break off with the first gusts of wind. It is noteworthy that the first serious outbreaks of these two beetles occurred in the Albert Falls district.

History and Morphology.

Though attention was first focussed on this disease in 1932-35 on account of the high mortality it caused in heavily thinned stands, it has quite possibly always been present. Due to the relatively high stockings per acre usual in wattle plantations in former years, however, its depredations were probably not noticed.

The disease is to be suspected either by the general yellowing or slight withering of all the foliage on a tree or by the dying of only one or two branches. Within a few days (5 to about 15) of these first signs, even the most vigorous trees die. One particular tree, 25 feet high and ideal in form and crown vigour, died within five days of the first sign of attack.

Distribution.

The stands which are so badly affected in the Albert Falls District are comprised of green wattle *Acacia decurrens,* but in one stand in which this species is mixed with *Acacia mollissima,* the two species seem to be equally affected.

The distribution of the disease has not as yet been carefully studied, but it appears to be fairly well distributed over the industry. The ages of trees mostly affected are between one to four or five years, though the deaths of highly vigorous trees of 7 years of age growing under good conditions in the Karkloof have also been recorded.

Causes and General Discussion.

A representative sample of material comprising roots, root collars, stem, branch-wood and foliage were submitted to the Government mycologists at Pretoria and Cedara. Both isolated a *Pestalozzia.* In Pretoria another fungus which did not fructify was isolated from most of the material submitted, and at Cedara a *Fusarium* was obtained. Inoculations of both stems and roots of young wattles at Cedara with pure cultures of *Fusarium* produced no visible result.

The extent to which *Schizophyllum commune* is associated with dead and dying trees in the Albert Falls district was considered by Mr. Gill, the Botanist who examined the Cedara material, to be sufficient to make it at least a suspect, and suggested that "the wattle under temporarily unfavourable environmental conditions can be attacked by various weakly parasitic fungi. The weakened trees may subsequently not be able to regain their natural resistance to attack. If this possibility should prove a fact, the investigations will need very detailed work as the fungi causing the trouble will give negative results when tried out in the inoculation experiments on healthy trees growing under normal conditions."

From material recently collected from a young tree that had died, Dr. Elaine Laughton, who kindly examined the material, reported that the very fine roots and main lateral root were all infected by a dark fungus, but that she had not made successful isolation cultures. The few she had made looked (in the absence of fruiting bodies) like *Diplodea natalensis.* She added that this is the fungus that she got on *Acacia* affected by gummosis shewing a "heavy black zone down at the base of the stem and main root at Sabie, Eastern Transvaal. This fungus was identified at Kew as a *Diplodea,* similar in all respect to *Diplodea natalensis* recorded from Natal on Citrus and also on the same host in Southern Rhodesia. It is, however, possible that a soil-inhabiting fungus, *Rhizoctonia,* is primarily concerned in the infection of the Acacias as it is in Southern Rhodesia on Citrus investigated by Hopkins. This root and stem-base disease can be severe if soil conditions tend to be water logged or suddenly dried out" (unpublished reports 1930-38...Elaine Laughton).

Collar Rot.

This disease was first reported in 1930 from the eastern Cape, where a large number of trees in one plantation were attacked. A rot started in the roots of the trees in the region of the root collar, with the result that they were eventually blown over by wind. The same phenomenon occurs throughout the wattle plantations of Natal and in some cases assumes quite alarming proportions (see Fig. 4).

Again the age at which the trees are attacked varies from about a year to three or four years and the incidence of the attacks does not seem to be affected by the vigour of the trees.

Causes.

So far the outbreak of this disease in the eastern Cape has, to our knowledge, been the only one which has been examined, first by Miss Lurie and later by Dr. Elaine Laughton. The fungus isolated by Miss Lurie was identified tentatively as a *Rhizoctonia,* while in similar material, Dr. Laughton made mention of a *Macrophoma* (14), later identified at Kew as *Diplodea natalensis.*

Froghopper Damage.

Importance.

The damage referred to here is second only to bagworm in the the amount of loss caused to the industry. It is conservatively estimated that half the area under wattles gets one bad attack of froghopper every 10 years. Assuming that the area under wattles is 450,000 acres (the last agricultural census figures are rather higher than this) and that each froghopper attack means a loss of 30/- per acre, the annual losses to the industry amount to well over £30,000 (see Fig. 5 and 6).

Morphology and Nature of Damage Caused.

The first sign of attack is the curling of leaves at the tips of the branches and the leading shoot. In severe attacks leaflet shedding and often complete defoliation follows. Thus weakened, many trees succumb to white ant damage or other causes, but generally they recover fairly well. The portions of the tree to recover first are the lower branches. On the uppermost branches and the leading shoot the resultant effect is that of a witch's broom, for they are the shoots which are most severely attacked.

The losses caused by "froghopper" may be classified as follows :—

1. Loss of both diameter and height increment during the period of the attack.
2. The cost of eradicating the weeds which spring up during the period of the reduced crown vigour.
3. The cost of pruning the lower branches which recover first and commence competing with the main shoot. Unless these are checked there is considerable dissipation of growth.
4. The value of timber lost due to permanent deformity of the main stem.

As regards the first item it should be explained that the loss of growth is due partly to the actual length of time the trees remain defoliated but also to the temporary loss of vigour resulting not only from this defoliation but also from root damage due to the necessary extra weeding, when trees exceeding about 10 feet in height are attacked.

History and Distribution.

Froghopper damage, like gummosis, appears always to have been prevalent in the industry. At present there is little information available as to the effect of soils and climates of various types on its incidence. All that can be said is that there are areas that do not appear to suffer from froghopper. It occurs, however, over a wide range of soil and rainfall conditions. From rather general observations, it would appear that froghopper is almost invariably severe on sandy soils. The fact that severe froghopper attacks are found also on other soil types would make it appear purely a coincidence that the available phosphates in the sandy soils are almost invariably lower than in the heavier soils (15). This point is to be investigated.

Correlation with Age and Vigour.

Froghopper damage is most marked in young, vigorous plantations. Trees from a few inches to 10 to 15 feet in height are often completely defoliated, but once trees are 25 feet high little damage is done. There appears to be no correlation between vigour and incidence of attack. It should be stated here, however, that our ideas on vigour are not absolute and that perhaps we are apt to regard as vigorous, trees which are growing fast and have good well formed pyramidal shape. Had we another means of measuring vigour such as by leaf composition, our ideas might change.

Causes.

The fact that froghopper damage is caused by insects, was first suspected by certain growers and technical sylviculturists, and was finally established by entomologists in 1925.

The insects concerned are the jassid *Bythoscopis cedaranus* Naudé and the capsid *Lygidolon laevigatum* Reuf. The dates of the appearance of these insects are not accurately known, but the affects of their depredations become evident from about February onwards. These insects suck the juices from the tender shoots of the wattles and according to Ripley (1929), they inject poison with their saliva into the plant thereby causing a temporary cessation of growth in the shoots attacked.

The extent to which the damage can be controlled by maintaining the health of the trees has been referred to by Ripley (7). He maintains that though vigorous trees suffer badly they recover well. A point he makes, moreover, is that there is occasionally a correlation between incidence of attack and fertilising, presumably with superphosphates, but says that it would appear that fertilised trees suffer less owing to their increased canopy and possibly also to an increased resistance to the poisonous effect of the saliva injected by the insects.

From our point of view, this is an interesting observation. There are, of course, no data on the subject, but it is a matter of common experience that trees fertilised after an attack of froghopper do recover very well. This stimulation of growth has to be carefully watched, for the lower branches are apt to develop particularly rapidly, and unless checked it might seem that fertilising had increased the deformity due to froghopper.

We would like to emphasise here that we realise fully that the effect of superphosphate in reducing the incidence of attack in certain instances may be due purely to the increased amounts of foliage produced; the more foliage produced the less the attack per unit of foliage, but the possibility of the explanation being either physiological or chemical must also be considered.

Leaf Shedding.

This is a phenomenon which seems to be correlated with periods of high rainfall or with periods of drought, and it is often a matter of great disappointment to growers when their trees which have been given the best cultural treatment and are well formed and vigorous, quite suddenly start shedding their leaves. This is a relatively minor physiological complaint to which it is hoped to devote some attention in future.

Eelworm.

The appearance of eelworm (*Heterodera marioni* Cornu) is first apparent through its stunting affect on the trees. Roots of affected trees present a characteristic knotted effect. These apparently pathological conditions are caused by the presence of the nematode. In young trees an infestation is occasionally fatal necessitating complete re-establishment, but generally the trees recover.

No data on the correlation of the incidence of attack with environmental factors are available, but in any investigation of control measures these will have to be collected.

General Discussion.

In view of the potential danger of collar rot and the Albert Falls disease and of the losses caused by gummosis, these diseases are of great significance to the wattle industry. Their study is of immediate practical importance. In addition, the losses to growers as a result of froghopper damage and to a much smaller extent, eelworm, are serious. The possibility of controlling outbreaks of these latter pests are to be investigated by Government wattle entomologists. Meanwhile, in view of the physiological nature of the damage they do, the subject of their control should receive attention in any comprehensive investigation of wattle pathology. The only control measures that have been suggested hitherto, are based upon sound cultural practice as outlined by Craib (2) and Ripley (7). There is, however, little correlation between cultural practice and the incidence of the diseases mentioned, except that the incidence is usually more obvious in well treated stands due to the smaller number of trees maintained per acre.

As regards the Albert Falls disease and collar rot, it is fairly certain that these are due to fungi and that the normal procedure is to identify the causal organism before considering control measures. But the point arises, that assuming we do discover and are able to identify the causal organism, are we really much nearer a solution of the problem? Control measures to be effective, should cost only a few shillings per acre per rotation in view of the relatively low value of the wattle crop. Fungicidal measures appear to be out of the question so there seems to be little point in awaiting the results of the systematist before initiating studies of preventive measures. We may meanwhile therefore consider the lines along which such studies may best be pursued.

For the investigation of the whole field of wattle pathology outlined above, the following lines of approach are being considered :—

(1) *Strain.* The selection of wattle strains which are more resistant to the diseases concerned will be a long process, but one which deserves investigation. As far as froghopper is concerned, the exploratory work being carried out by the Natal Tanning Extract Company at Seven Oaks is promising.

(2) *Sylvicultural Treatment.* Sound sylvicultural practice involves the initiation of stands with large numbers of indivduals per acre and their gradual thinning, so that after each thinning, as far as possible, only the healthiest and most vigorous trees are left. In this manner inherently susceptible trees are reduced to a minimum in the final crop, and seed can be collected from the healthiest of these for re-establishment purposes. Sound sylvicultural practice has a marked effect on vigour, but as there is no obvious correlation between vigour and the incidence of the various diseases, the practice from the point of view of prevention cannot be said to be of much assistance. The pruning of preventitious leading shoots after froghopper is, of course, an essential corrective measure.

(3) *Fungicides and Insecticides.* It is probable, according to entomological opinion, that an efficient poison will be found which will control froghopper. It may be some time before work on this subject can be seriously commenced, however, and several years before it can be completed. In view of the importance of the subject to the industry the initiation of work along these lines is eagerly awaited. We hope to exploit fully a recent offer of assistance in mycological work.

(4) *Ecology.* The ecology of the four diseases is very imperfectly known and further studies in this direction will doubtless throw much light on the subject. On this aspect too, it is hoped to collect some data, particularly in connection with likely symbiotic fungi and bacteria.

(5) *Physiology.* Willis (12) and Young (13) draw attention to the results of experimental work in plant pathology during the past ten years, which tend to explain the incidence of a large variety of diseases, and even insect pests, on the basis of some mineral deficiency or excess. Unbalanced diets reduce resistance to the point where plants become susceptible to

> disease. In many cases such conditions have been cured by applications of very small quantities of certain elements. This work implies that insufficient importance has, in the past, been attached to these "trace elements" in particular, and to balanced diets in general, in the prevention of disease and the explanation of many obscure pathological conditions.

Though it is not intended here to review the literature on the subject, we mention the following example of an element which may have a bearing in wattle physiology, and particularly on wattle gummosis. Warrington (10) has shown that boron, in minute quantities, accelerates the growth in pot cultures of broad beans by as much as 50 per cent.; that it is essential for the normal symbiotic mode of life of the nodular bacteria of *Vicia faba;* and that it checks necrosis in the phloem and cambial cells of *Citrus,* broad beans, sugar-beet, etc. According to Dennis and O'Brien (4) there is evidence, in certain cases, of increased resistance to fungal attacks resulting from the application of very small quantities of this element. Dennis (3) has shown that boron is often absorbed out of all proportion to the amount present in the soil, and that it is essential not as a catalyst, but as a constituent of compounds formed in plant metabolism.

It has been shewn also that boron is correlated with the water economy of certain plants. This point may be significant in view of the fact that the wattle seems to be most susceptible to disease during the first few years of life when development is most rapid, and a loss of balance between crown and root, due to temporary water maladjustment, may cause temporary physiological derangement of some sort.

If the susceptibility of wattles to attacks of disease is basically a physiological one, it is not suggested that the lack of boron is causative. The case of boron has merely been mentioned to illustrate a point. We have actually used borax and boracic acid in recent field fertiliser experiments, but the plots have not been in operation long enough to yield possible differences due to treatment. We feel, however, that there is sufficient evidence in literature on mineral deficiencies, due particularly to trace elements causing lowered resistance, to warrant a thorough investigation of the subject as regards wattles.

From the chemical point of view the study of the resistance of wattles to disease presents certain practical difficulties. To initiate a series of detailed analyses (including trace elements in the foliage and bark from soils representing diseased and disease free cases) would involve a great deal of time and expense, and may eventually yield negative results. Any chemical findings involving differences in composition between diseased and healthy trees would have to be confirmed by elaborate field experiments on different soil types and under different climatic conditions. This would involve investigations spread over a number of years.

We have decided upon an easier means of approaching the whole problem, and our proposed line of work may, for the sake of convenience, be divided into two sections as follows:—

Role of Minor Trace Elements.

By means of the injection method, which has recently been used with considerable success in New Zealand by Atkinson (1), we will endeavour to trace the element or elements which will either inhibit or produce the pathological conditions described. Very dilute concentrations of soluble mineral salts of various elements will be tested out for their effect on the disease in trees by being injected into the tree trunk. Any effects subsequent to the injection will be recorded. Any results from this investigation will be confirmed by chemical analysis of the foliage and bark of the tree for the element in question.

Common Plant Constituents.

In this connection we shall be more concerned with the relative proportion of the elements than with the individual percentages present as determined by analysis. Du Frenor (5) states that "for each genotype of plant cultivated under certain conditions with a view to production of a certain product, there must exist an optimum ratio between the different nutrients, a ratio such that each will be utilised to the best advantage in the development of the crop. What in ultimate analysis constitutes deficiency of an element is the inability of the cell, lacking the relatively sufficient quantity of that element, to metabolise completely the other elements at its disposal, an inability which manifests itself by a slackening of growth or a diminution in yield and which also provokes accumulation in the vacuolar solution of non-utilised or incompletely metabolished, absorbed substances." Reviewing the literature we glean that boron deficiency for example in turnips or sugar bean manifests itself first in the largest and quickest growing members of the crop. McLarty (6) shows that this is also true in the case of apple trees. As far as *Acacia mollissima* is concerned, we may mention that it is maintained by many growers that the faster the growth of the trees the greater the incidence of the disease. Though the little data at our disposal does not support this view, further investigation of the subject is necessary before any final conclusion in the matter can be obtained.

The only problem which we have tackled so far is gummosis. Owing to the complexity of the problem, it was decided at the commencement of this investigation to collect but single composite samples comprising foliage and bark collected from several average trees in particular plantations representing cases of diseased and disease-free trees. Bark samples were also collected representing disease-free bark on diseased trees. For the purpose of possible correlation with the composition of the trees, soil samples were collected from the same areas in which the sampled trees were growing.

Although certain analyses on foliage and bark samples have been carried out, our data are too incomplete at present to warrant publication. We may state, however, in conclusion, that the results we have thus far obtained indicate that the higher phosphate content in wattle foliage is associated with a lower CaO content and *vice versa*. An interesting fact that has also emerged from the investigation is that the average protein content of the foliage (leaves only, no twigs) of *Acacia mollissima* (4 years old) is approximately 19.5 per cent. protein. This high protein content accounts for the fact that the young foliage of wattle is so relished by stock.

SUMMARY.

The diseases of wattle plantations in South Africa, known as gummosis, the Albert Falls disease, root collar rot, "froghopper" and one or two others, are described.

Our knowledge about them is summarised, special mention being made of the general lack of correlation of sound cultural practice with the freedom from disease.

The general lines that are to be followed in studying these diseases, and particularly the measures for their control, are discussed.

Particular emphasis is laid upon the possible value of balanced and complete "diets," with special reference to trace elements in increasing the resistance of wattles to these diseases.

REFERENCES.

1. ATKINSON, T. D. "Progress Report on the Investigation of Corky Pit of Apples." N.Z.T./Ci Tech.16.316-19. 1935.

2. CRAIB, I. J. "The Wattle Industry in South Africa." Brit. Emp. Forestry Conference. 1935.

3. DENNIS, R. W. C. "A Review of Developments in the Applications of Boron in Agriculture and Horticulture." 1935-37. S.O.A. University of Cambridge.

4. DENNIS, R. W. C. and O'BRIEN, D. G. "Boron in Agriculture." West Scot. Agric. College. Plant Husb. Department 1936.

5. DU FRENOY J. "Les Maladies de Carence." Le Congres internat. Technique et chimique des Industries agricoles. Scheveninque 1937. Comptes rendus pages 468-76.

6. MCLARTY, H. R. "Some Observations on Physiological Diseases in Apple in British Columbia." Sci. Agriculture pages 636-50. 1928.

7. RIPLEY, L. B. "Froghopper in Wattles." Farming in S.A. August, 1929.

8. ROBERTSON, C. C. "A Reconnaissance of the Forest Trees of Australia." 1923.

9. VAN DER BYL, P. A. "A study on a Mottled Disease of the Black Wattle." Un. Dept. Agriculture Division, Bot. Science Bulletin No. 4. 1914.

10. WARRINGTON, K. "The Effect of Boric Acid and Borax on the Broad Bean and Certain other Plants." Ann. Bot. 1923.

11. WILLIAMS, C. O. "South African Tanning Materials" (Part IV) Bibliography and References. 1923. Sc. Bulletin No. 133 Dept. of Agric. S.A.

12. WILLIS, L. G. "Bibliography of References to the Literature on the Minor Elements and their Relation to the Science of Plant Nutrition." Chil. Nit. Ed. Bur. Inc. 1936. (second edition). (This publication contains some 3,000 extracts and references).

13. YOUNG, R. S. "Certain Rarer Elements in Soils and Fertilisers and their Role in Plant Growth." N.Y. (Cornel Agri. Expt. Sta.) Mem. 174, 2-70 (1925).

14. Unpublished Mycological Reports by the Principal Plant Pathologist, Division of Plant Industry, Elaine Laughton, Lurie and Geo. Gill. (1930-38).

15. Unpublished Report on Wattle Soils—Division of Chemical Services (1937.)

WOODEN HOUSES

By H. A. Read

THE value of the Crown forest estate of the Union is in the neighbourhood of £15-16,000,000. Much of this consists of plantations, which cover an area of 339,242 acres. Within the near future the trees will reach the stage when they can be cut and the timber brought into the markets of the Union.

The State has also incurred very large expenditure on sub-economic building loans involving (with past expenditure) a total of £13,000,000 (statement by the Minister of Public Works in the House of Assembly, 26th August, 1938). More money will probably be required as the scheme progresses.

Wooden houses are common in Canada, the United States, Germany, Italy, Australia, New Zealand and elsewhere, and there seems to be no reason why an appreciable quantity of the timber to be produced in the near future from the Union's forests should not be used for this purpose.

A reduction of 25 per cent. or more in the capital cost of the buildings might result.

An informative memorandum has been issued recently by the Timber Development Association of Victoria (Australia): A house having an area of 1,000 square feet, hardwood frames, hardwood weather boards, ceiling and lining of fibrous plaster, hardwood flooring and tiled roof, plus the usual fittings, can be put up for £455 10s. Australian currency, say £365 Union currency. (The same house built, let us say in Johannesburg, of brick would cost not less than £650-£700). Various other examples are given of small houses varying in price in Australian currency from £450 to £595. The average price per square, i.e., 100 square feet flooring area, is given as £45 2s. 6d. = £36 South African currency.

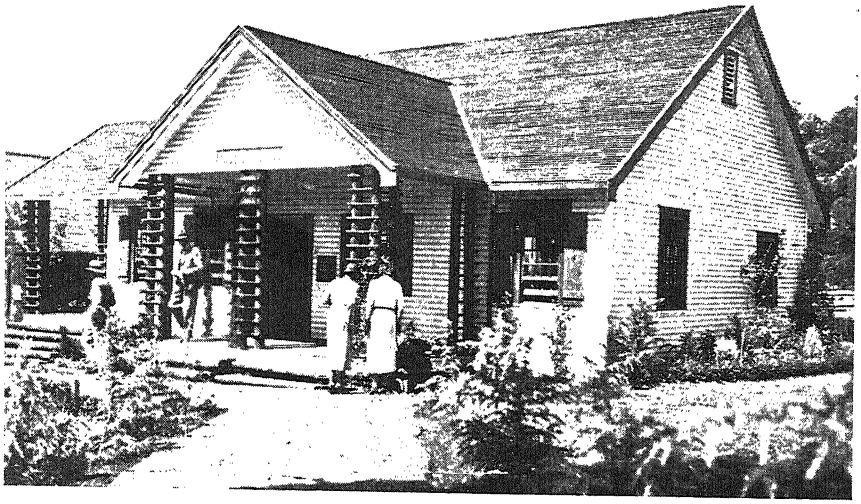
Durability. Wooden houses are in every respect as durable as brick houses. (This is supported by world-wide experience).

Appearance. Wooden houses can be as attractive in appearance as any other houses.

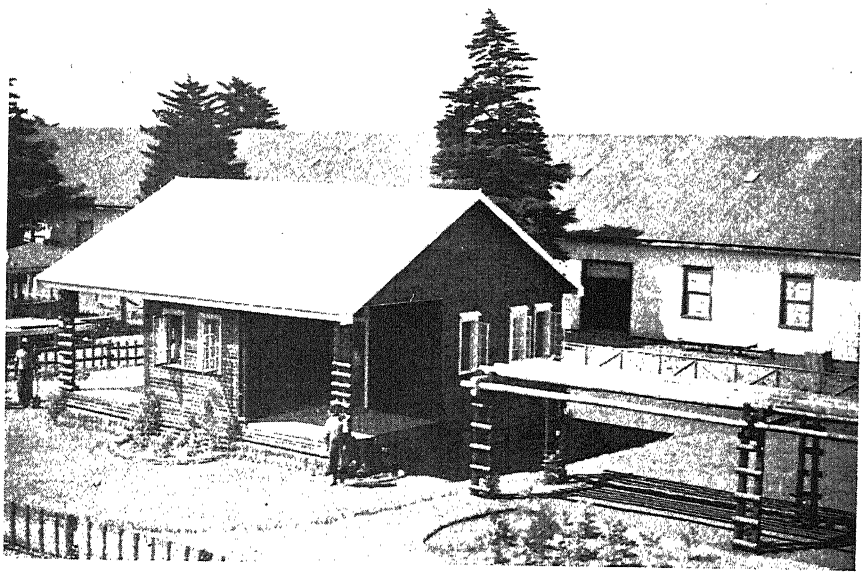
Maintenance. Comparison of 1,100 brick houses with 1,300 wooden houses (statement by the British Columbia Trade Commissioner stationed in London) shows that wooden houses cost 30 per cent. less to maintain than brick houses. These houses were at Well Hill near Woolwich.

Health. A properly constructed wooden house is 100 per cent. dry, cool in summer and warm in winter.

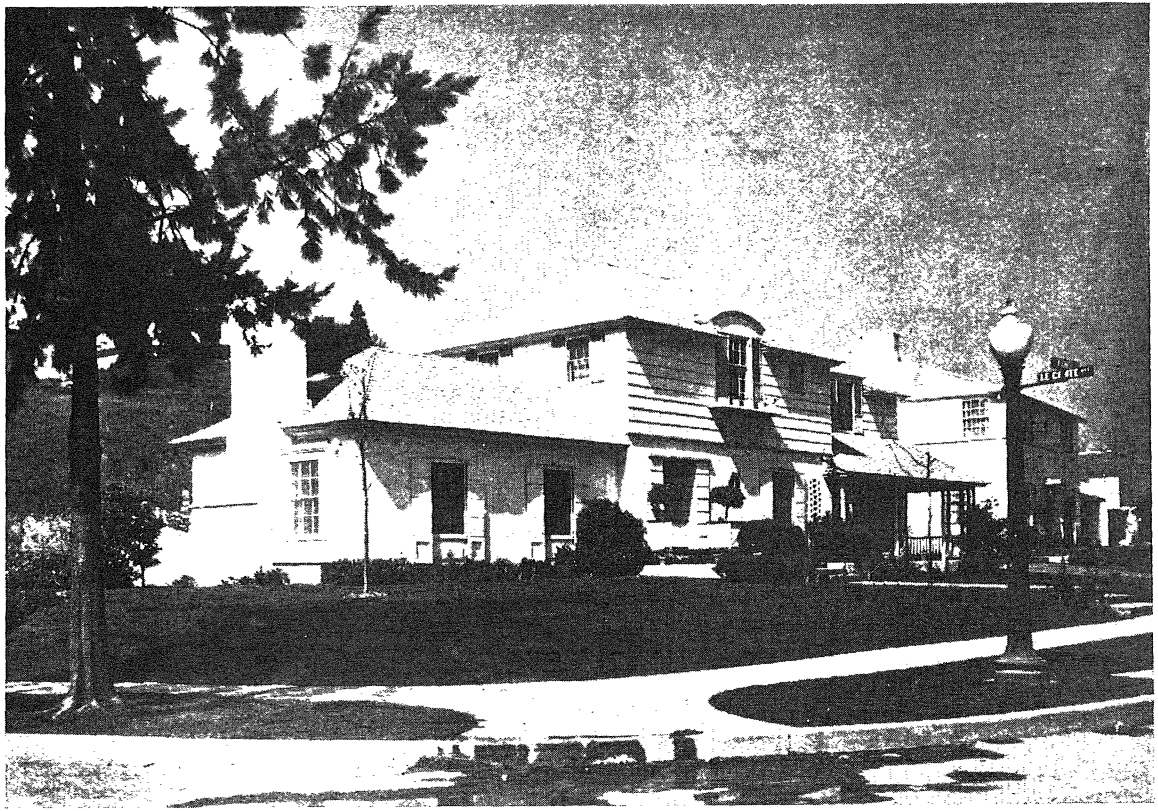
Insulation. The loss of heat through brick walls is higher than the loss through wooden walls.



Four room Wooden Cottage erected at the Empire Exhibition, Johannesburg, in 1936, at a total cost of £450.



Three room Seaside Bungalow erected at Port Elizabeth Agricultural Show Ground in 11 days at a total cost of £300.



Wooden House in Los Angeles. Designed by Allan S. Siple

Photo by courtesy of "Wood."

Fire-risk. An extensive survey in the United States by the National Board of Fire Underwriters of the United States showed that in 266,636 masonry buildings examined the fires per 1,000 buildings per annum were 25.2, whilst the examination of 962,938 wooden houses gave a rate of 16.25 fires per 1,000 buildings. This survey comprised 81 cities.

Flexibility. A timber building can easily be removed and replaced on a new site without unreasonable expense. Additions can also be made without any difficulty.

By processes devised in recent years timber at small expense can be stabilised and made fireproof and immune against attacks of white ants and other insects. Methods of construction have been developed which prevent white ants getting access to house timbers. The introduction of these methods of preservation and construction into the timber trade of the Union is only a matter of time.

From the owners' point of view if, without detracting from health and comfort, the capital cost of homes can be appreciably reduced, it is obviously a matter of national importance. The position of the young married couple starting life, for example, in Johannesburg is that an undue proportion of income must be paid for rent, whether for a house or flat. A modest house in the suburbs can hardly be secured for less than £10 to £12 a month, whilst even a small flat commands a rent of £7 to £10 per month. It can be well understood that children in such circumstances are not wanted.

Contrast this position with Australia (Melbourne). The following figures are quoted by the Timber Development Association of Victoria :—

Land	£167
House (1,000 sq. ft.) Loan from society three-quarter of total cost of house and land (£667)	500
Cash to complete deposit	Nil
Total cost of house and land	£667

Sum to be repaid to society — £500 at 3s. 3d. per week per £100 (P. and I.) = 16s. 3d. or £42 5s. per annum Australian currency for interest and redemption (equivalent to £33 16s. South African currency).

Various schemes are in force in Australia by which substantial advances for building can be procured by small owners of land enabling them at very low rates to own their own houses, repayable as to the sum borrowed over a period of 20 years.

Emphasis must be placed upon the importance of the proper preparation and preservation of timber used in house construction. In other parts of the world it has been found quite recently that wooden houses—and even wood in brick houses—have been rapidly destroyed by various forms of fungal attack and by insects, and extensive replacements have been necessary. This points to the importance of the co-ordination of the sawmiller's work with recent scientific developments.

A note of warning is sounded by the Association, which says that departure from the principle of obtaining supplies through the recognised (trade) channels has resulted in heavy losses in the case of previous Government housing schemes, notably the War Service Homes scheme.

In the Union to-day local authorities are largely bound by building regulations of their own making, which may debar the use of such houses. Regulations should not, however, be regarded as the laws of the Medes and Persians, and once any unfounded prejudices and objections to the use of wood for the construction of houses are overcome, any necessary amendments in regulations should follow. The prospective house-owner is to-day faced not only with the high price of suburban plots, but with unreasonable capital expenditure owing to existing regulations. He is entitled to have those regulations amended so as to enable him to put up a cheap and comfortable home. It can safely be said that had South Africa been a well timbered country, building regulations would not be permitted to debar the construction of wooden houses. But there are lots of jerry-built brick houses. With its growing plantations and a gradually increasing output of suitable timber, South Africa must become "wood conscious."

The following recently appeared in the Timber Trades Journal:—

> Visitors to Great Britain from overseas countries, where timber houses are a feature of building construction, are sometimes puzzled by the innate conservatism of people here in regard to timber houses. A Canadian, for instance, expresses his wonder why more use is not made of wood in building houses in Britain. "Such houses," he states, "are cheap, they are durable. If properly looked after they are pleasant to live in, cool in summer and warm in winter, and they can be made very attractive. A further advantage in a country where re-housing is still a pressing national need, they can be erected quickly and they admit of production on a large scale.
>
> The real objection to wooden houses, I suppose, is simply the national passion for solidity. The average Englishman regards a wooden house as a temporary and jimcrack affair hardly better than a tent. He doesn't feel that he has a house at all unless it is built of brick.

In 1927 the London County Council imported 12 pre-cut timber houses from Sweden and erected them on their Beacontree Estate beside houses of brick construction. These timber houses are stated to be amongst the few on the Estate with which they have had no trouble.

The introduction on a large scale of wooden houses in substitution for masonry houses will run counter to numerous existing interests. But the matter is one of national importance and any obstacle thus arising must be overcome. *Tempora mutantur.*

The demand for housing schemes is wide-spread, but the present cost of housing is much too high. Rents are excessive in relation to earnings. If necessary, further Government action should be taken to ensure the lowest possible rates for interest and redemption of building loans.

The contemplated extended use of wood from State forests is not confined to dwellings. The taxpayer often wonders at the large sums spent in the erection of costly school buildings built of bricks which are often transported for great distances. These school buildings are said to be meant to last 100 years. But changes occur in educational ideas. Is it certain that 50 years hence the present ideas will hold good? Might not a trial be given to a wooden school building of the open-air type developed in Europe? The Railway Administration also might profitably consider wooden buildings in place of masonry houses.

The development of wooden buildings and dwellings connotes the establishment of woodworking industries in various parts of the country where the volume of available timber would justify the capital expenditure on modern timber-working plant, including preservation and seasoning plants.

Close co-operation between the various State departments is essential. The forester, when establishing plantations in past years, has been influenced largely by the suitability of the soil and climatic conditions for growing trees. The Department's first consideration was to seek forest conditions, and in doing so it had in some instances to take land in regions not readily accessible to rail or markets. Instances can be given where large quantities of timber are approaching maturity in areas as yet unserved by railway communication or even by suitable heavy motor traffic roads. The cost of timber in its final stages, fit for placing on the market, can obviously be reduced if adequate transport facilities are available. The forester having followed the ground, railways should follow the trees. A timber industry in continuous production would provide a steady flow of traffic. Many subsidiary uses for timber would also develop, e.g., boxes and crates for the fruit and vegetable industry would add to the stability of the ventures. In Sweden building sections are produced from pine trees having as small a diameter as 6 inches. Taking everything into consideration, it should be possible to produce timber for buildings and general purposes at much lower prices than now rule for imported timbers upon which the Union has relied for so many years.

A quotation from the annual report of the Division of Forestry for the year ended 31st March, 1937, is appropriate :—

> Great interest was shown in the possibilities of soft wood of sawable dimensions from the plantations. This is due largely to the increasing prices of fruit and industrial boxes and to the local product obtaining a firm hold on the market, and also to confidence gained from the Department's demonstrations of the possibilty of converting smaller dimensioned wood. Some of the sawmills operating at plantations in the Transvaal are gradually improving their plants and the other methods of manufacture. The day of crude, ill-equipped and under-capitalised plants is over as a means of exploiting the timber that has become available. In order to protect the interests of the Department and trade generally some control will have to be exercised over the quality of the products of mills drawing their supplies from Government plantations. In order to achieve this, new contracts provide for Government withholding of supplies of logs where the products are not up to suitable standard.

To conclude: A well considered scheme for the construction of wooden houses and buildings would mean:—

1. The fruition of the large State investment in forestry.
2. The development of the timber industry in areas adjacent to Government plantations.
3. The expansion of adjacent towns.
4. Payable railway development.
5. Reduction in the cost of living.
6. The acquisition by more citizens of their own homes.
7. A healthy life for young married people; and
8. More cradles.

THINNING, PRUNING AND MANAGEMENT STUDIES OF THE MAIN EXOTIC CONIFERS GROWN IN SOUTH AFRICA.

[We have been privileged to read in manuscript a work under the above title, written by Dr. I. J. Craib, Senior Research Officer in the Division of Forestry. The work is extensive, consisting of five parts, aggregating in length between thirty and forty thousand words, and including 92 tables and 29 figures; but the matters of which it treats are of such importance, and its intrinsic interest so great, that we avail ourselves with pleasure of the opportunity of presenting to our readers the following synopsis of it prepared by its author.

Eventual *extenso* publication of Dr. Craib's work will be announced in due course in these pages.—*Editor.*]

PART I.

Thinning Schedules and Intermediate Yields for *Pinus insignis* (*P. radiata*), *P. pinaster* and *P. patula* under Contemporary Thinning Practice.

BECAUSE of experience gained and data collected upon the growth of exotic conifers in commercial plantations in South Africa, during approximately 50 years, the time is regarded as opportune for the presentation and critical analysis of all the available information.

In order to solve the two main issues now confronting local afforestation, namely the standardization of silvicultural technique and the determination of utilizable yields from intermediate fellings, classic and non-controversial procedure is applied. Data upon mean height over mean diameter, based upon several thousand sample trees, is given for the three most important coniferous species. Mean height and mean diameter are then correlated with age and site quality. As existing permanent sample plots do not adequately represent all site qualities and ages, individual sample trees, fully covering the range of all ages and sites, are used for this purpose. The validity of the results is confirmed by checking them with the data from hundreds of sample plots.

Data are then analysed to show that it is not possible to base suitable thinning regimes on height, diameter or age, but that a composite basis must be used. The derived schedules incorporate the standard principles that initial espacements should be relatively close, that canopy should be maintained and that for a given age, poor site qualities should carry more trees than favourable sites. These schedules are in conformity with general overseas practice, moreover, for they show that for a given size, either in height or diameter, poor sites carry as many, if not more, trees than favourable sites.

Rotation periods for the various species and sites are tentatively laid down. Data are given to show the effects of various degrees of thinning on mean diameter, both of the trees remaining and those removed. Standard volume tables, based upon alinement charts for the three species, are presented, and also percentage utilization tables for one inch utilization classes down to a minimum limit of two inches in diameter under bark and a log length of six feet.

The method of applying the data presented in the standard tables is shown. From the three factors, age, diameter and density, which are easily ascertainable for any compartment, the volume of wood available for sale during the next five or ten year period may be determined within a reasonable degree of accuracy.

PART II.

Pruning for the Production of Knot-free Lumber under Contemporary Thinning Practice.

Having decided that four inches is the minimum economic radius of clear lumber that may be imposed upon the pruned knotty core, data on taper and bark thickness for trees of all sizes are given for the three species dealt with previously. Tables are presented which show in detail, the increment of each log in the tree correlated with its permissible pruning. These tables demonstrate that, with the diameter increment associated with contemporary thinning practice, only very limited pruning is economically permissible, and then only when it involves the removal of living branches. Maximum pruning to a height of 22 feet is restricted to fast-growing species, whereas none is permissible on poor sites. For slow-growing species the anticipated diameter at maturity for all sites is too low to permit of pruning.

The data show, moreover, that the time within which pruning may be undertaken, is exceedingly limited. A delay of one or two years in its application tends to discount its economic effectiveness.

Data are given which demonstrate the effect of removing vigorously growing branches, to various degrees, upon subsequent increment. The reduction in height and diameter increment, due to the removal of branches up to half the total living crown length, appears to be only slight and temporary. The adverse effect of removing more than this proportion is marked.

The discussion concludes with a table which shows how small a percentage of the total volume, anticipated from the various species on the different site qualities, is likely to be affected by permissible and economic pruning under contemporary thinning practice.

PART III.

Analysis of Anticipated Yields and Profitability under Contemporary Thinning Practice.

In order to assess the results of contemporary thinning practice, it is necessary to know the composition in size classes of both intermediate and final fellings. Percentage stand tables, based upon alinement charts, are given to show the distribution of trees around their mean diameters for a wide range in size classes, both for trees removed in

thinning and for those comprising the remaining stand. A basic ratio of value is then tentatively laid down as a basis upon which to assess value for the logs of various sizes produced.

Tables are introduced which show, in detail, the volumes anticipated for the three main species as regards both intermediate and final yields for the three site qualities, their distributions in size classes, and their relative values. A further table shows how low the mean annual increments per acre for second and third site qualities are, relative to first. These data are then analysed to show that, not only is the rate of increment on the poorer sites low relative to the better sites, but also that wood produced on the poorer sites will fall mainly within categories of low value and price. This is shown to be particularly true of slow-growing species like *Pinus pinaster.* A special point, supported by data, is made of the fact that the mean annual value increments per acre for the poorer site qualities, relative to the better site qualities, are appreciably lower than in a similar comparison of the relative mean annual volume increments per acre under contemporary thinning practice.

Data are given to show the percentage volume and value relationships between thinnings and total merchantable yield. They show that thinnings are of relatively low economic significance. When a tentative monetary value is assigned to each ratio of value, data are presented to show the gross financial returns anticipated per acre for the various species and site qualities. After considering costs of production, all coniferous plantations in the Union are divided into categories of various rates of growth, and each category is subdivided into the site qualities likely to exist in the field. Assuming that the area in South Africa still to be afforested will be comparable with that already afforested, and that the choice of species in future will be comparable with that of the past, data are presented to show the areas which will have to be felled annually for all species and site qualities when normality in age-class distribution has been reached. The yield, both from thinnings and final fellings, given by this acreage is then analysed in size classes. From information now available, it is deduced, moreover, that the Union is never likely to supply more than half its timber requirements.

From a critical analysis of the data given, the following conclusions are drawn. A high percentage of the area afforested with conifers is comprised of slow-growing or least profitable species. Only a small percentage of the total area afforested may, moreover, be regarded as first quality. As the cost of production is high, the total revenue for the great majority of plantations is unlikely to cover the expenditure, particularly if the latter is compounded at a small rate of interest. It is estimated that, of the total eventual annual volume production, almost half will be comprised of small sizes, which have low value and doubtful marketability, and that thinnings will contribute more than half of this material. While contemporary thinning practice connotes intensity of management and high cost of production, its total contribution at finality is low relative to volume and markedly so relative to value. Only a very small percentage of logs, produced under contemporary practice, will be large enough to command a high price due to large size and freedom from knots because of pruning.

PART IV.

Modification of Silvicultural Practice to Increase Profitability.

The possibility of obtaining logs of considerably larger size and greater profitability than under existing silvicultural procedure, by the extension of the rotation periods, is discussed and discarded as being technically unsound. A drastic modification of the growing space permitted per tree, provides the only basis upon which to improve the present position where desirable.

Current policy with regard to thinning research is discussed at some length. Data are given in detail for nine sample plots on thinning at Weza, Natal. While these plots are located on a site which appears to lack uniformity, trees on all the plots have grown almost precisely in a manner dictated by the various growing spaces allotted to them. The plots show that thinning has a very marked effect upon diameter increment, little influence upon predominant height growth during youth, little influence upon volume production per acre when the area is fully stocked, but a marked effect upon the range of size-classes of the logs produced. The plots show that response, after suppression, is high when stands are thinned beyond silvicultural limits, low when thinned within silvicultural limits. Data are given to show the effect of thinning on branch size, its effect on grass and weed control, the effect of pruning living branches on increment, and the effect of grass and weed competition and soil preparation on initial growth. The retarding effect on growth of extensive and cheap establishment methods as opposed to intensive and costly methods, is so small that the saving of considerable expenditure on these operations is recommended.

Reference is made to the results of local investigations which show that rate of growth, age being equal, appears to have no observable effect on wood density and therefore on wood strength.

The yield tables for the three main coniferous species given previously are then critically examined. Of the results anticipated, only those given by fast and medium-fast growing species on first quality sites are regarded as satisfactory, both economically and commercially. These species on average and poor sites, and slow-growing species on all sites, offer considerable scope for improvement. Data are given in detail as to the manner in which drastic changes in afforestation and thinning technique are likely to improve the prospects in these latter instances.

Into the management schedules recommended for future application are incorporated wide initial espacements, with pitting or spot-preparation to replace ploughing or broadcast picking by hand. On the poorer site qualities and for slow-growing species, initial espacements are considerably widened. Special attention is drawn to the desirability of maintaining indigenous shrubby and herbaceous vegetation in the Midland and Western Conservancies as a permanent mixture with coniferous crops to improve soil properties. The times and degrees of thinning are so arranged as to provide for a mean diameter at maturity of approximately 18 inches for all sites and all species. The gradual pruning of living branches to a height of 22 feet for the trees which are to mature, is recommended for all stands.

These proposed schedules incorporate radical departures from standard silvicultural technique. Competition between the trees comprising a stand is reduced by thinning in direct proportion to the degree with which increment falls short of the growth rate now available for fast-growing species on favourable sites, under contemporary thinning practice. Intense competition is permitted, as heretofore, in stands of fast-growing species on favourable sites, little competition in stands of slow-growing species on poor sites. The growth rate, in terms of number of annual rings per inch, now given by fast-growing species on favourable sites under a conservative thinning regime, is applied as a standard for all sites and species. It is anticipated that under the proposed schedules the mean number of rings per inch for all species will range between four and eight. The proposed schedules embody the principle that, not upon the basis of size but upon the basis of age, poor site qualities should carry less trees than favourable ones.

The poorer the site the longer are trees allowed to remain free-growing. The increase in branch size anticipated is countered by the drastic pruning outlined and by the fact that the unpruned portion of the boles is expected to contain larger tight knots, as opposed to the smaller potentially loose ones under contemporary practice. Attention is drawn to the necessity for genetic research on the isolation of strains of good form and small branch size, examples of which already occur frequently.

Detailed data are given to show the anticipated results of the proposed changes in silvicultural policy. Volumes are calculated upon the basis of the assumption that heavier thinning will not increase predominant height, and that the intermediate yield from thinnings will be less than under conservative thinning, while the final yield will remain unchanged in volume. The data given anticipate a considerable reduction in cost of production, a reduction by approximately half of the small material of doubtful value and marketability, and an eventual increase of timber with a diameter of 12 inches or more under bark from 16 to 36 million cubic feet per annum, without extending the previous rotation periods. This is likely to exert a marked influence upon pruning potentialities, saleability and profitability. Attention is drawn to the fact that the proposed silvicultural technique will not be applicable for the production of small poles, half-rounds and droppers, the demand for which will in any case, be relatively very small.

Complete management tables of initial espacements, thinning and pruning are given for contemporary and proposed practice correlated with a table of predominant height over age for the assessment of site quality. The tables proposed for future application are recommended only for very young stands or for stands as yet unplanted.

PART V.

Recommendations Regarding the Treatment of Existing Coniferous Stands.

The principles underlying the recommendations given in Part IV were accepted for general adoption in practice by a conference of senior officers of the Division of Forestry. Subsequently it was therefore

necessary to examine fully the present position regarding existing coniferous stands of the older age-classes and to make recommendations regarding their treatment.

As the sound application of widely-differing thinning schedules is dependent upon a reasonably accurate assessment of site quality, revised data on predominant height over age are given for *Pinus insignis, P. pinaster, P. patula* and for *P. longifolia, P. caribaea* and *P. taeda*. Tables are given to show that existing stands are reasonably overstocked relative to conservative thinning regimes and heavily overstocked relative to the regimes proposed for young stands. Information is presented upon the degree to which lower branches in existing stands are dead due to mutual competition, and the depth in the log to which these branches will cause loose or potentially loose knots. The removal of dead branches by pruning is discussed, and the fact that increment subsequent to such pruning should equal approximately 12 inches in diameter at any point on the bole, is stressed. The diameters of the predominants in the older age-classes are already so large that the addition of a further 12 inches of growth is beyond the bounds of probability.

A table shows the present distribution of age-classes in the Union for conifers of the various growth rates. From this table it is inferred that the application of the proposed schedules to even the youngest age-classes will place field operations seriously in arrears, particularly in relation to the existing labour shortage.

Data are given to show the volume of wood from fellings now available for utilization, and the rate at which this volume is likely to increase to the year 1980. The total volume of wood available for sale to this date is arranged so that it falls short of the total increment by a volume sufficient to stock a normal forest with a complete range of age-classes. The minima milling facilities to cope with the expected production are indicated. The implications of the utilization programme are then analysed. The data show that the erection of mills will have to be greatly accelerated and that production will reach its maximum about 40 years hence under present afforestation policy. Vast sums of money will have to be invested in mills and in their running and maintenance costs. By 1980 it is estimated that a utilization staff of 15,000 men will be necessary and that the gross value of saleable commodities will exceed £3,000,000 per annum from state-owned plantations alone.

These figures are all the more striking when considered in relation to the meagre wood-conversion facilities now available, and the reluctance with which private enterprise has been willing to enter this new industry. For these reasons particular emphasis is laid upon the adverse repercussions upon silviculture which are likely to take place if utilization does not keep pace with the fellings demanded by silvicultural needs. If future experience shows that the timely completion of the programme is not possible, thinning irrespective of utilization, state assistance to private enterprise and the curtailment of the rate of afforestation are suggested for consideration as factors by which a most undesirable technical position might be ameliorated.

Taking into account the limitations imposed upon academically ideal silvicultural treatment by practical considerations, the conclusion

is reached that radical departures from standard thinning technique in the older age classes will not be possible. Management schedules for the treatment of stands as yet unplanted, for the treatment of young stands and for the treatment of relatively old stands are finally drawn up.

In conclusion the paper draws attention to the modifications, quantitative rather than qualitative, which future researches are likely to make necessary in the recommendations now given. The purpose of the report is to provide standards by which decisions of management may be arrived at, rather than to provide, ready-made, the decisions themselves.

I.J.C.

PULP AND PAPER MAKING AS A SOUTH AFRICAN INDUSTRY

By P. J. A. LOSEBY.

(Forest Products Institute, Pretoria)

THE manufacture of paper, which consists of a mat of minute fibres felted and compressed to form a sheet, requires as raw material a fibrous substance of stable composition. The natural source of such material lies in the vegetable kingdom, where the vascular tissues of a great number of plants provide Cellulose fibres of suitable physical characteristics and chemical composition. The disintegration of the raw material into ultimate fibres or small aggregates of fibres and the felting of the fibres into a sheet are two distinct production operations, the former being known as Pulping and the latter as Paper-making.

Raw Materials

The phenomenal growth which has taken place in the pulp and paper making industry during the last 100 years has created a very great demand for suitable sources of fibre. The supplies of waste textiles soon proving insufficient, new sources of supply were sought and, with the devising of chemical processes for the disintegration of vegetable matter, a vast new field of raw material was opened up. The grasses—straw, esparto and the like—provided suitable fibres, but cheapness and dependability of supply caused wood to assume the paramount position in this field and to-day about 85 per cent. of the paper produced in the world is made from wood. A recent American Committee[1] reported that "although pulp can be produced from many fibrous materials, no source of cellulose has yet been discovered which, either in suitability for most types of paper pulp or in cost per unit weight, challenges the supremacy of wood—in short, wood is the basic raw material for paper pulp."

For general utility papers such as newsprint, book, writing and wrapping paper, wood fulfils the demand almost exclusively, but the special qualities of fibre obtained from esparto grass, rags and other sources retain for them a place in the field of specialities and fine papers.

The principal factors which determine the suitability of a particular raw material fall under two heads:—

(a) *Physical and chemical characteristics*: The ultimate fibre requires to be of suitable strength and dimensions and to possess the ability to felt into a sheet. The encrusting substances should be readily removable in the pulping process, and no refractory substances should be present which require additional chemicals for their elimination.

(b) *Cheapness and dependability of supply*: Not only has the raw material to be of extremely low value, but it should also be capable of being transported to the mill site in large quantities at low cost.

Further, dependability and continuity of supply are equally essential. The industry to-day is so organised and the product so priced that no potential paper-making material warrants further consideration unless it fulfils all the conditions under this head. The fact that the industry makes use to a large extent of what may be termed waste material—notably wood of small dimensions which would fail to yield reasonable profits as saw timber—and the fact that the greater part of the raw materials is obtained from natural forest resources, suggest that there is little likelihood for the economic success of an undertaking which depends for its supplies on crops, whether they be trees or other plants, which are especially raised for this purpose and no other.

Processes of Manufacture

There are several different methods of pulping, each having its special use in the production of particular types of paper from particular types of raw material. Mechanical pulping is perhaps the most widely employed process, being especially adapted for the production of newsprint from soft, white, non-resinous woods. Disintegration of the wood is effected by means of mechanical abrasion against a rotating grindstone. The fact that the wood is imperfectly reduced to individual fibres and that none of the unstable substances which encrust the cellulose fibres are removed, results in high yields of a pulp which is weak and brittle and subject to deterioration. Where the pulp is made up into newsprint, a percentage of chemically produced fibre is added to give the sheet sufficient strength to pass through the rotary printing presses. The chief requirement for the successful operation of this process is cheap electric power for driving the grinders.

Pulps for the manufacture of the better quality papers are produced almost entirely by chemical means. The more common chemical processes are similar in principle but possess distinguishing features in the chemicals used, their preparation and recovery. Where wood is employed as raw material, it is reduced to small chips about an inch in length, which are fed together with the requisite amount of chemical solution into a pressure cylinder, or digester, of several tons capacity. The cooking process, or digestion, is effected at a high temperature and under considerable steam pressure which is maintained until all encrusting substances have entered into solution; the charge is then "blown" into a washing tank, or diffuser, in which the fibrous cellulose pulp is subjected to a thorough washing in order to remove all dissolved substances and chemical reaction products. In this way a reduction of the raw material to individual fibres consisting of almost 100 per cent. pure cellulose is obtained.

Much is still imperfectly understood of the chemical composition of wood and the reactions which take place during pulping processes, all of which have been developed in the last 100 years; and the chemistry of the materials and processes continues to be an active field of research. All forms of chemical pulping are based on the fact that the cellulosic walls of plant fibres resist to a marked degree the action of chemicals, and reagents have been found which, under certain conditions, dissolve out the less stable infiltrates and substances which encrust the fibres while leaving the cellulose practically unaffected.

The Soda Process, which was the first practical chemical method of producing pulp, makes use of the solvent power of caustic soda solution. The somewhat drastic action of this chemical results in the solution of some of the cellulose and low yields of pulp are obtained. The merits of the process, however, lie in the fact that a pure cellulose is obtained, the pulp produced being capable of easy bleaching to a fine white; and, though it has been largely ousted by other processes for the production of utility papers, it still maintains its usefulness for the production of certain types of pulp and the pulping of certain raw materials. Alkaline processes are eminently suited for the pulping of resinous woods, notably the pines, and the present wide use of paper for wrapping purposes probably owes its origin to the development of the Sulphate Process which enables such woods to be turned to account for the production of strong brown wrapping or "Kraft" papers. In this method of pulping, the activity of the alkali is curbed to a certain extent and high yields of tough, pliable papers are obtained.

It is essential for the economic operation of both these processes that the alkali be recovered as completely as possible at the conclusion of the digestion, and recovery plants are thus an important feature of this type of mill. The spent cooking liquor is concentrated by evaporation and then incinerated with the resultant formation of sodium carbonate, or soda ash. In the Soda Process, the loss of the sodium element is made good at this stage by the addition of a further quantity of soda ash, the whole amount being then taken up in water and, by the addition of lime, re-causticised to form a solution of caustic soda of the concentration required for the cooking liquor. The Sulphate Process on the other hand, derives its name from the sodium sulphate, or salt cake, which is added, instead of soda ash, to make good sodium losses. By processes of smelting and causticising, the cooking liquor containing caustic soda and sodium sulphide in solution is produced from the recovered and added chemicals. In the alkaline processes, then, the following processing materials are required: coal for steam raising, lime for the causticising plant, and soda ash in the Soda Process or salt cake in the Sulphate Process.

The Sulphite Process finds very wide application in the production of strong white papers from non-resinous softwoods such as spruce, balsam and hemlock. Here the active chemical is of an acid nature, consisting of a solution of calcium and magnesium bisulphites and an excess of sulphur dioxide. A long cooking period is necessary and the digester and other equipment require to be fitted with acid-proof linings. The cooking liquor is prepared by burning sulphur, or pyrites if it is more readily available, and either impinging the sulphur dioxide gas against lumps of dolomite under a shower of water, or absorbing the gas in a suspension of lime in water. The chief processing materials required are therefore coal, sulphur or pyrites, and limestone. It has not been found practicable to recover and re-use the spent chemicals, with the result that streams into which the effluent from this process are allowed to escape are liable to serious pollution.

The Pomilio Process was fairly recently developed in Italy where it is chiefly applied to the pulping of cereal straws. It is, however, of more than passing interest on account of its adoption at a pulp and

paper mill that has been established recently on the Witwatersrand. In South Africa one does not require to consider the local availability of plant, spares and specialist engineers in weighing the merits of one process against those of another. Moreover, with the production of quantities of agricultural waste products, such as wheat straw, the harvesting of which is incidental to the winning of the major product, an excellent raw material is available. In selecting this process for one of its pioneer pulp mills, local industry has used to advantage its detachment from traditional convention to arrive at a sound decision. The chief processing material used is common salt which is subjected to electrolysis to produce chlorine gas and caustic soda, both of which are required for the digestion of the raw material and the refining of the pulp. The requirement of coal is small since no high pressure steam is needed in the cooking process, but a large amount of electrical energy is necessary for the electrolytic process. Pomilio[2] gives the following requirements for the production of one ton (2,240 lbs.) of air dry pulp:

> Straw—5,000 lbs.; salt—1,000 lbs.; energy, direct current—1,200 KW; energy, alternating current—200 KW; steam, low pressure for cooking—1,500 lbs.; steam, low pressure for drying—5,000 lbs.

Paper-Making

Before the pulp can be formed into the finished sheet, it is first screened and then subjected to a process known as beating, by which the aggregates of fibres are broken down into individual elements and are frayed out to increase their felting properties. If required, the pulp is bleached and the necessary size, filler and colour are added.

As a dilute, uniform suspension in water, the pulp is poured on to the endless moving wire gauze, or Fourdrinier, of the paper machine. While the wire is subjected to transverse vibration to cause even felting of the fibres, the bulk of the water drains off, and the web is then passed over suction boxes and through roller presses in order to remove further water and to consolidate the sheet. Drying is completed by taking the sheet over series of steam-heated rotating cylinders and the paper is given its final finish by running it through a stack of polished steel rollers tightly pressed together. The whole process of forming the sheet is far more elaborate than this brief outline would suggest, the various stages being controlled and modified according to the type of paper which is produced.

Other Uses of Pulp

Apart from the manufacture of paper, there are two major uses of pulp. Pulpboard for building, insulating and cardboard accounts for the consumption of large quantities of pulp. A lesser degree of refinement is required for pulp for making into boards, and, besides the more common methods of pulping, a number of patent methods of manufacturing pulpboard have been devised.

A use for pulp which has increased phenomenally during the last few decades has been found in the manufacture of artificial silk or rayon. Any process capable of yielding a very pure cellulose may be employed, and, since the fibrous nature of the cellulose is destroyed

during subsequent treatment, the physical qualities of the raw fibre do not require to be taken into account. Processes for the production of rayon from pulp are all similar in principle, employing a solvent to dissolve the cellulose and then forcing the solution through minute orifices into a fixing medium. Originally the pure cellulose obtainable from cotton linters was the chief material used for rayon production but to-day wood pulp is being used to an increasing extent.

There is a variety of other uses for cellulose which include the manufacture of explosives, lacquers, plastics, pressed containers, *papier maché*, celluloid, cellophane, cellulose wadding and artificial leather.

The Industry Overseas

Pulp mills are located as close as possible to the supplies of raw materials, which, on account of their bulk, will not stand extensive transportation except over natural waterways. One finds, thus, that the pulping industry is centred chiefly in the more important coniferous forest zones of the Northern Hemisphere—notably in the United States of America, Canada, Scandinavia, Germany and Finland. Paper mills, on the other hand, are not governed by the same limitations and are situated more in relation to the distribution of the demand. Where possible, however, pulp and paper mills are combined on the same site.

The high cost of the necessary plant for pulp mills and more especially for paper mills makes this a highly capitalised industry depending on a very large output for its economic success. In presenting an article on this subject in South Africa, it is desirable to emphasise that the average capital cost of overseas undertakings is probably considerably more than a million pounds and that the minimum capital outlay required for an economic unit would be several hundred thousand pounds.

The following figures summarise the world production of pulp[3]:

World Production of Wood Pulp
(Thousands of Long Tons)

	1930	1934	1936
United States	4,134	3,961	5,103
Canada	3,232	3,247	4,005
Sweden	2,409	2,824	3,105
Germany	2,055	1,979	2,330
Finland	1,059	1,543	1,945
Norway	917	967	976
Japan (including Sakhalin and Korea)	636	705	773
U.S.S.R.	378	517	689
France	143	276	337
Austria	312	314	331
Newfoundland	257	274	282
Czechoslovakia	308	320	282
Poland	106	121	142
Italy	130	111	137
Other countries	541	567	580
Total	16,617	17,726	21,017

The pulps which form the chief constituents of world production are, in order of importance, mechanical pulp for the production of newsprint; sulphite pulp which forms part of the newsprint furnish and is used in the manufacture of strong and fine white and semi-white papers; sulphate pulp which is employed chiefly in the manufacture of kraft papers; and soda pulp which forms a large part of the furnish of opaque and bulky papers such as book paper and blotting paper.

A feature of the industry during the last decade or more has been the increasing use of pine wood as raw material with a resultant rapid extension in the application of the sulphate process. The trend is illustrated by the following figures which give the combined production of sulphate pulp in the United States of America, Canada, Sweden and Finland and its relation to the total production of wood pulp in these countries[4] :

Year	Sulphate Pulp (thousands of short tons)	Percentage of total output of wood pulp
1925	1,125	12%
1930	2,031	17%
1936	3,674	23%

Recent developments in the pulp and paper making industry have been directed towards the exploitation of new raw materials and the establishment of mills in countries remote from the chief producing centres of the world. One of the most noteworthy features of recent years has been the opening up of new pulpwood resources in the Southern States of the United States of America, which, as is the case with all new ventures in this field, has been the result of many years of patient research, in this instance carried out at the Forest Products Laboratory at Madison and by Dr. Herty and his associates at the Pulp and Paper Laboratory of the Industrial Council at Savannah. There are some 140 million acres of forest land in the Southern States, the chief species being Southern Pines, and it is only recently that the country has achieved the practical realisation of these vast resources. The chief pulping process employed is the sulphate process, though production is not confined to kraft paper. Bleached and semi-bleached sulphate papers compete with those made from spruce sulphite pulp, but perhaps the most notable development has been the pulping of these pines both by the sulphite process to produce a pulp of sufficient purity for rayon manufacture and also by the mechanical process. Dr. Herty has shown that young southern pines in which no heartwood has formed contain no more resin than spruce, and he has thus rather confounded the popular idea that pine trees grown in this region, which is the centre of the naval stores industry of the United States, are essentially resinous. These developments are a striking illustration of the general utility of certain species of pine as paper making material and demonstrate the possibility of pulps produced from this wood being used as substitutes for the products of the older established spruce pulp mills.

TABLE I.

VALUE OF PAPER AND PAPER PRODUCTS IMPORTED INTO THE UNION OF SOUTH AFRICA.

	1913 £	1922 £	1927 £	1932 £	1935 £	1936 £	1937 £
Newsprint	203,070[x]	176,159	257,077	174,441	226,381	292,210	363,899
Other printing	——	223,763	411,664	231,008	390,362	493,587	735,372
Wrapping paper	77,320	146,744	242,772	185,991	313,258	391,039	592,501
Cardboard, Linenboard, Strawboard and Leatherboard	——	56,335	142,880	103,435	200,996	249,429	310,838
Cardboard boxes, jars, cups and paper bags	64,846	90,186	27,526	22,148	38,566	58,830	76,730
Wallpaper	40,895	40,435	36,756	19,286	29,613	34,105	32,333
Other paper	35	45,201	216,736	165,215	313,313	326,004	375,212
Total	386,166	778,823	1,335,411	901,524	1,512,489	1,845,204	2,486,885

x — includes other printing.

During recent years there has been active development in the Australian manufacture of wood pulp to replace the imported pulp which until lately was exclusively used in her well established paper industry. The trend of the pulping industry in that country is based on the astute utilisation of her natural *Eucalyptus* resources. A 25,000 ton pulp mill in Tasmania has modified certain processes to make possible the production of Eucalyptus pulp for the manufacture of fine papers. Another large Tasmanian undertaking aims at producing newsprint from *Eucalyptus regnans* by the mechanical process, while a third project located in Victoria plans to employ a modification of the sulphate process for the production of Eucalyptus pulp for wrapping papers. There is also under consideration a scheme which envisages the manufacture of kraft pulp and boards from the thinnings of Government pine plantations.

As result of a comprehensive investigation[5] of the pulp and paper making qualities of certain woods grown in New Zealand, commercial interest has been awakened, and a mill will shortly be in operation there which will produce pulp from indigenous woods and from the thinnings of exotic pine plantations, chiefly *Pinus insignis*.

PULP AND PAPER MAKING IN SOUTH AFRICA.

In order to give an idea of the consumption of paper in this country, figures showing the imports of the various classes of paper have been extracted from the Annual Statement of Trade and Shipping for the Union of South Africa. Table I shows the value of imports and Table II gives the amount of the more important types of paper imported.

TABLE II.

IMPORTS OF NEWSPRINT, OTHER PRINTING PAPER AND WRAPPING PAPER INTO THE UNION OF SOUTH AFRICA

(in short tons)

	Newsprint	Other Printing	Wrapping Paper
1922	13,988	5,069	4,695
1927	18,668	14,022	11,781
1932	18,383	12,747	13,522
1935	27,022	19,567	24,217
1936	34,939	24,878	28,966
1937	41,550	33,946	36,636

The figures are not strictly indicative of the consumption since a certain amount of paper is re-exported and a small quantity is manufactured locally. Neither of these amounts, however, is of sufficient magnitude to warrant consideration when the matter is regarded in a general way.

South African Raw Materials :

A number of potential raw materials has been investigated from time to time, the experiments in the majority of cases being limited to an evaluation on a laboratory scale.

Tambookie Grass: English[6] demonstrated on a laboratory scale that a fair yield of pulp was obtainable from Tambookie grass (*Hyperrhenice glauca*) when cooked by the soda process under rather drastic conditions. The pulp bleached fairly readily and had a fibre length of 1.5 mm., or approximately the same as that of esparto grass.

Papyrus: A laboratory evaluation of Papyrus grown in Zululand was carried out at the Imperial Institute in 1914, a very low yield of good quality pulp being reported. A few years later the commercial exploitation of this material was attempted, but the venture did not prove a success.

Black Wattle: The wood of Black Wattle (*Acacia mollissima*) was first tested for pulp and paper making in 1899, when an unfavourable report was obtained, and at a later date conflicting opinions were expressed by various manufacturing firms. The Imperial Institute carried out small scale laboratory trials in 1917 and reported that a fair yield of short fibred pulp was obtainable from the wood, while a poor yield of low quality pulp was obtainable from spent wattle bark.

Pilot experiments carried out by English[7] in the laboratory of the Forest Products Institute, Pretoria, showed that Black Wattle could be pulped fairly readily by the soda process, while in a further investigation it was found that a pulp apparently suitable for the manufacture of newsprint could be produced by the newly developed semi-chemical process. A study of production costs at that time, however, suggested that there was little likelihood of the economic success of a commercial undertaking.

Eucalyptus species: English[7] showed on a laboratary scale that *Eucalyptus saligna, E. Maideni* and other species could be pulped readily by the soda process using low concentrations of alkali. A laboratory experiment carried out concurrently at the Imperial Institute demonstrated that *E. saligna* wood from a six year old tree furnished an excellent yield of pulp under comparatively mild treatment with caustic soda, the product being somewhat similar to that obtained from poplar on a commercial scale. The pulp was further evaluated to determine its suitability for the manufacture of artificial silk, the results suggesting that drastic treatment would be necessary to produce cellulose of sufficient purity.

A recent trial carried out by the Natronzellstof und Papierfabriken in Germany showed that *E. saligna* wood was not suitable for the production of kraft paper but that it might be used for the manufacture of book and other papers. The bark of this wood was found to give a low yield of poor quality pulp.

Baobab: The inner bark of the baobab tree (*Adansonia digitata*) used to be imported into England for the production of pulp of the highest quality and strength, but it has subsequently been superseded by other woods. Owing to the scattered distribution of the tree and to the fact that only a very small part of the tree can be utilized, further attempts to exploit this raw material have proved unsuccessful.

Milletia Sutherlandii: The pulping qualities of this tree, which is found in the Transkei, were investigated on account of the fact that the wood is practically useless for the production of saw timber. It

was found that rather drastic cooking conditions were required but that a good yield of pulp of fine quality was obtainable. The inaccessibility and restricted occurrence of the tree would, however, weigh adversely against its use for the manufacture of pulp.

Pinus patula: The availability of increasing quantities of material of small dimensions as yielded by thinnings and other wood too small to use as saw timber led to an investigation into the pulping qualities of *Pinus patula*. The experiments were initiated at the Imperial Institute where the soda process was employed in a pilot trial. The results were sufficiently promising to warrant further study which was carried out by the writer[8] in the laboratory of the Forest Products Institute. It was shown that the wood was adaptable to pulping by the sulphate process and that a fair quality of kraft paper could be obtained. The investigation was taken a step further when, in co-operation with the proprietors of the Premier Paper Mill, Johannesburg, the wood was pulped by this process in a ½-ton digester and the pulp run over a paper machine. The indications were that no special difficulties would be encountered in treating the wood on a commercial scale.

Other Materials: Certain other pines occur sufficiently extensively in plantations in this country to enable them to be classed as potential paper making materials. *Pinus pinaster* which has been planted widely in the Cape Province is a species which is pulped with success in the Landes in France to produce kraft paper. *P. insignis*, another major plantation species, was the subject of a comprehensive investigation at the Forest Products Laboratory, Madison[5], on behalf of the New Zealand Government. It was established that the wood could be pulped by the mechanical, sulphate and sulphite processes. *P. taeda*, *P. palustris* and *P. caribaea* which have been planted in various parts of the country are species which are used for pulping in the Southern States of U.S.A.

Pine Pulpwood available in Government Plantations:

From both the technical and the economic aspects, it is considered that plantation grown pines represent the most promising source of pulpwood in this country. In the management of plantations for the production of saw timber, a large amount of material of small dimensions is produced in thinning operations, and in the exploitation of mature stands a considerable volume of logs either too small or too crooked for the saw goes to waste. The use of such material for pulping would be an important factor in the complete utilisation of our national assets.

In 1937 the total area under coniferous species in state owned plantations was 226,000 acres, which was distributed as follows (the principal species being given in each case):

Western Cape Province, between Cape Town and Riversdale: 28,300 acres: *Pinus pinaster, P. insignis* and *P. canariensis*.

Midlands, Cape Province—George, Knysna, Tzitzikamma area: 69,300 acres: *P. pinaster, P. insignis, P. canariensis, P. caribaea* and *P. taeda*.

Eastern Cape Province, near Hankey and along the Amatola Mountains:
22,000 acres: *P. pinaster, P. canariensis, P. longifolia, P. insignis* and *P. patula*.

Transkei:

5,300 acres: *P. patula, P. longifolia, P. canariensis, P. caribaea* and *P. taeda.*

Natal and Zululand:

22,300 acres: *P. longifolia, P. caribaea, P. taeda, P. patula* and *P. palustris.*

Orange Free State:

2,300 acres: Cypress, *P. pinaster, P. longifolia,* and *P. patula.*

Transvaal:

76,700 acres: *P. patula, P. longifolia, P. taeda, P. caribaea* and *P. palustris.*

It is estimated that these plantations are capable of yielding five-and-a-half million cubic feet of pulpwood per annum, i.e. material from three to five inches in diameter and crooked logs which cannot be used for saw timber. This amount is made up approximately as follows:

Western Cape Province	400,000 cu. ft.
Midlands	2,400,000 cu. ft.
Eastern Cape Province	400,000 cu. ft.
Transkei	90,000 cu. ft.
Natal and Orange Free State	300,000 cu. ft.
Transvaal	1,910,000 cu. ft.
	5,500,000 cu. ft.

A large area of private coniferous plantations has not been included in the above figures, and it should be pointed out that the Government is still actively extending its plantations.

Availability of Processing Materials:

A short survey of the availability of the more important processing materials required in pulp and paper making is not out of place because the cost of these materials represents about one-quarter of the total cost of producing pulp.

Soda Ash: Though fairly considerable quantities of soda ash are available in local deposits, there is some doubt as to whether the material could be put on the market at a price to compete with the imported article.

Lime: Abundant supplies of lime are available in various parts of the Union.

Coal: Local supplies of this commodity are abundant, deposits being exploited in all four provinces, with the largest output from the Transvaal and Natal. Price at pit head ranges from three to seven shillings per ton, but f.o.r. prices at various centres are often appreciably higher.

Sulphur does not occur in the Union but quantities of pyrites suitable for the production of sulphur dioxide are available at low prices.

Salt: Practically unlimited supplies of salt are obtainable from pans in the Orange Free State, Cape Province and the Transvaal. The domestic price per bag varies 5/3 and 9/- f.o.r. producer's station.

Salt Cake would probably have to be imported, as would *resin, alum* and *dyes*.

Water is required in very large quantities both in the process of manufacture and also for diluting the effluent, where this is liable to cause pollution. The paucity of large streams in the Union would necessitate very careful consideration being given to the location of pulp mills using certain processes, more especially the sulphite process.

Economics of the Industry

From the nature of things it is difficult to make a broad statement on the economic prospects of the pulp and paper industry in South Africa. Each project has so many individual features and the cost of raw and processing materials may be so different in one locality from those obtaining in another that each case requires consideration on its own merits. Despite various advantages, such as remoteness from overseas producing centres, the general availability of cheap unskilled labour and the cheapness of some processing materials in certain areas, the consideration of certain projects thought to be favourably situated suggests that there is little likelihood of any great margin over a fair profit when the local product is required to compete with imported pulp and paper at to-day's prices. On account of the great distances between the more important centres of population, it will be only in exceptional circumstances that a mill located to supply one of the principal markets will be able to compete on the market of one of the other larger centres. It is therefore probable that the pulp and paper industry will be confined to the operation of small units which, on account of the high capital outlay required, will be close to the smallest size of mill which can be run economically. A mill located to supply the needs of inland centres and dependent to a minimum on imported processing materials will, of course, be in the most favourable position, owing to the high cost of railage on the imported article. A mill which can operate successfully at the coast, however, will have the advantage of the wider market.

Present Status of the Industry in South Africa

The pioneers of successful paper making in the Union are the Premier Paper Mills, Johannesburg, who operate a paper factory at Klip River, Transvaal, in which imported sulphate pulp is converted into all grades of wrapping paper. The monthly output is in the neighbourhood of 100 tons and is shortly to be increased to 150 tons.

A company styled The South African Pulp and Paper Industries, Limited, was floated in 1936 with a capital of £750,000 with the object, *inter alia*, of erecting a factory to manufacture pulp by the

chlorine gas process perfected by Dr. Pomilio, and to install a paper mill to manufacture therefrom various grades of writing, printing (other than newsprint) and wrapping papers suitable for the local market. The possibility of producing cardboard, chemicals and other by-products was also envisaged. The buildings have been erected on a site at Geduld on the Witwatersrand. The plant has now been installed, and with the completion of technical arrangements, it is anticipated that the mill will very shortly enter the producing stage. It is proposed to manufacture about 14,000 tons of paper per annum from pulp produced from cereal straw and locally grown pine wood.

Another recently formed company, known as The National Pulp and Paper Company (South Africa), Limited, proposes to produce paper board from waste paper in a mill located at Durban.

The Union Government has entered into a 25-year contract to supply 750,000 cubic feet of *Pinus patula* pulpwood to be used in a pulp factory which private enterprise plans to establish at Sabie in the Eastern Transvaal. The original intention was to manufacture sulphate pulp for wrapping paper, but it is understood that later investigations have shown that the production of mechanical pulp is a practical possibility. The development of this scheme has been considerably hampered by difficulties in connection with the water requirements of the mill.

In connection with another proposed undertaking to be located near George, Cape Province, the State has contracted to supply one million cubic feet of pine (chiefly *Pinus pinaster*) pulpwood per annum over a 25-year period. It is planned to form a company with capital of about half-a-million pounds to produce some 15,000 tons of wrapping and board per annum.

Acknowledgments

The Secretary for Commerce and Industries and Mr. N. L. King and Mr. A. Jurriaanse of the Division of Forestry have kindly supplied data without which this paper would have been incomplete.

Summary

A general description of the more important processes of pulp manufacture is given and the essential characteristics of suitable raw materials are outlined. The industry in the chief producing centres of the world and recent developments in the industry are discussed. Figures showing the consumption of paper in South Africa are given. Reference is made to all local materials which have been evaluated to determine their paper making properties, while the availability of potential raw materials and the required processing materials are dealt with. Particulars are given of existing and projected commercial undertakings.

REFERENCES

(1) Report of the Fibrous Raw Materials Committee, 27 August, 1936, as quoted by Traquair : Wood Pulp Supply of the World, Paper Trade Journal, CV., 18, pp. 107-113, 28 October, 1937.

(2) Pomilio : Preparation of Cellulose from Agricultural By-Products by the Chlorine Process, Paper Trade Journal, LXXXVII., 18, p. 48, 1 November, 1928.

(3) Developments in the Empire Pulp and Paper Industries, Bulletin of the Imperial Institute, XXXVI., 2, pp. 165-179, 1938.

(4) Traquair : Wood Pulp Supply of the World, Paper Trade Journal, CV., 18, pp. 107-113, 28 October, 1937.

(5) Curran, Entrican et al. : Pulping and Papermaking Properties of Selected New Zealand Woods, New Zealand State Forest Service Bulletin No. 6, 1928.

(6) English : Tambookie Grass for Paper-making, S.A. Journal of Industries, November, 1924.

(7) English : Experimental Studies of Pulping South African Hardwoods, S.A. Journal of Science, XXVI., pp. 296-310, December, 1929.

(8) Loseby : An Evaluation of South African Grown *Pinus patula* by the Sulphate (Kraft) Process, Bulletin of the Imperial Institute, XXXIII., 2, pp. 162-171, 1935.

WAT STEEK DAAR IN 'N NAAM.

DEUR A. W. WINCKWORTH

(*Goewernementsbosbouer, Pretoria*)

SONDAGMÔRE in 'n plantasie in die Westelike Transvaal. 'n Boer klop aan die deur van die bosbouer.

,,Goeie dag, Meneer!'' se hy. ,,Verskoon my dat ek jou op Sondag kom lastig val, maar ek is net op pad om 'n brief te pos om sekere bome te bestel, en dog dat ek die entjie sou omry om te hoor of julle nie miskien van hulle in voorraad het nie. Dit is die Wit Seder wat ek wil he. Het julle daarvan?''

,,Wat bedoel u by die Wit Seder?'' vra die bosbouer. ,,Daar is meer dan een boomsoort wat so genoem word.''

,,Ek weet nie presies wat die botaniese naam daarvan is nie, maar hulle word baie in die *Farmer's Weekly* adverteer. Miskien het jy ook die advertensie gesien? Dit skyn 'n wonderlike boom te wees, wat teen miere en droogte bestand is, en goed in ons droë dele sal aard.''

,,Ja, ek het dit gesien. Ek dink u bedoel *Melia azedarach.*''

,,Ja, die naam het so geklink. Het jy daarvan?''

,,Nee, Meneer, dit spyt my van harte, maar ons het hulle nie.''

,,Ja, ek het so gedink. So gaan dit altyd met die regering! Hier het ons 'n goewernementsbosboudeskundige en 'n plantasie in ons midde, en ons moet darem na 'n privaat persoon gaan om van 'n ordentlike boom te hoor, en dit te kry. So gaan dit met alles.''

,,Meneer. Die enigste rede waarom ek hulle nie aankweek nie is omdat daar sover nog g'n aanvraag vir hulle was nie; maar terwyl u so praat sal ek u ook van 'n wonderlike boom vertel. Ons noem dit *Salix babylonica.* Hulle word so maklik aangekweek dat ek eenmaal 'n boer die steggies sien fyn kap het, en hulle in sy vleigrond gesaai en ingeëg het en daar het heelwat van gegroei.

,,Gewoonlik plant 'n mens somar 'n dik paal gedurende die winter maande, en dan het die mens gou 'n groot boom want dit groei baie vinnig. Dit kan in die vleigrond geplant word waar min ander soorte sal groei. Die meeste diere, en selfs ook hoenders, eet die jong takke en blare, die voedings-waarde waarvan byna gelyk staan met die van lusern. Die hout word vir vuurmaakhout en houtskool gebruik.

,,In die somer gee die bome ook goeie skaduwee vir diere. As die vee hulle nie afvreet nie, dan hang die jong lote met groen blare tot amper op die grond. Dit is 'n pragtige gesig.''

,,Man, het jy die boom? Wys hom vir my!''

Toe stap hulle die kwekery in en die boom word aangewys. Toe die boer die boom sien, toe val sy gesig, en hy roep uit, ,,Dit is dan somar ons gewone ou treurwilger.''

,,Ja, Meneer, dit is so.''

,,Man, ek sien nou ek was te haastig toe ek so teen jou uitgevaar het. Sê nou vir my, wat is die Wit Seder?''

,,Dit is ons gewone ou sering.''

,,Wat vertel jy my nou? Ons gewone sering? Man, ek is baie bly dat ek hierlangs gekom het, want op my plaas vervuil die goed in ons groentetuin, en ek is nou besig om honderde opslae uit te haal en te verbrand. En nou was ek op pad om nog vyf pond van hulle te koop. Alle magtig! Maar jy kan jouself lekker kul as jy alles glo wat jy in die koerante lees. Ek sal nooit weer bome koop voordat ek eers na jou kom nie.''

TEMPORARY TIMBER CHUTES AT DE HOEK PLANTATION

By D. W. PEARSE.

(*District Forest Officer, Tzaneen*)

ALTHOUGH the idea of timber chutes for the transfer of timber logs from higher to lower levels is not a new one, the planning, construction and putting into use of the temporary timber chutes at the Government Plantation known as de Hoek, in the Letaba District, by Forester W. M. Botha (Snr.) does perhaps constitute something new in the practice of Forestry in South Africa.

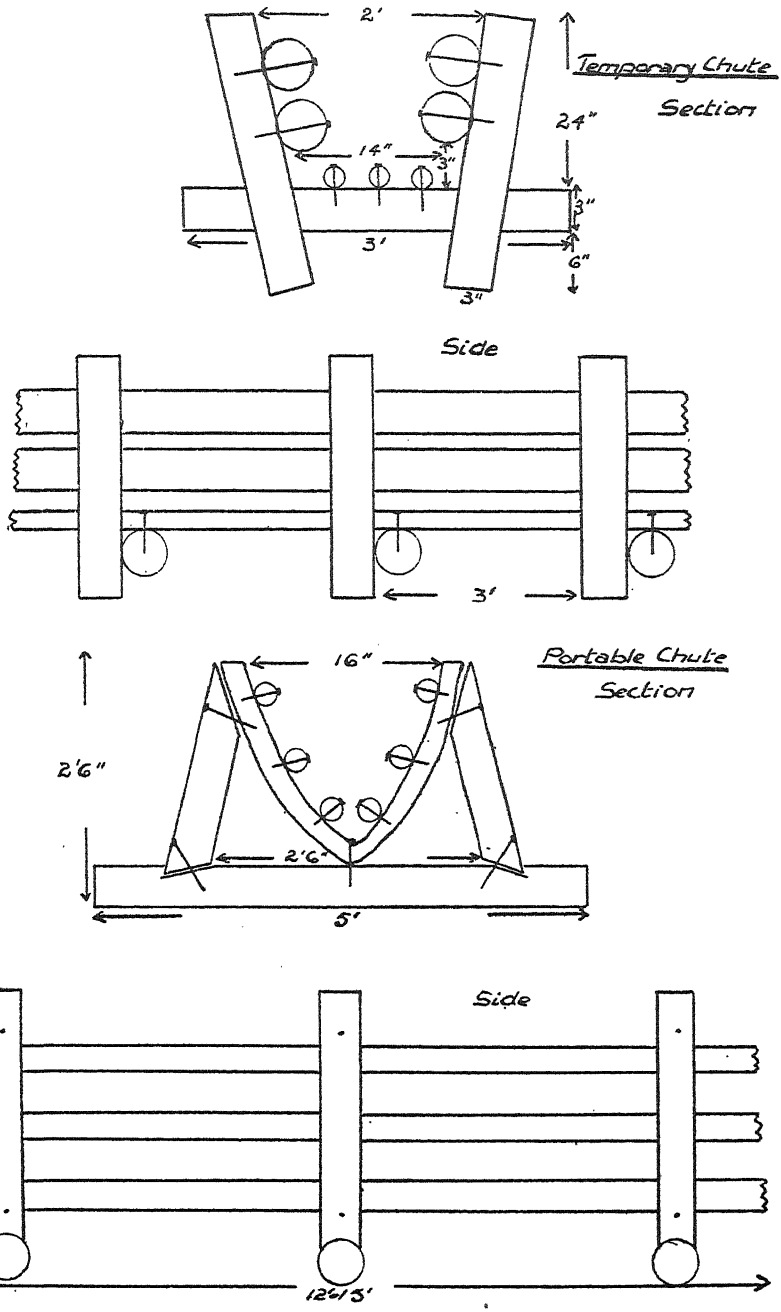
De Hoek Plantation, lying as it does on the Southern slopes of the Woodbush Mountains, comprises for the most part steeply sloping ground and when in 1934 large quantities of softwood timber began to be disposed of at a price which included delivery to roadside, it became necessary to devise some method which would deliver the timber to roadside more cheaply and more expeditiously than had hitherto been the case.

On his own initiative therefore, Forester Botha devised the method of conveying timber by chutes which, with improvements as time went on and advice now and then from visiting superior officers, has resulted in the present method of timber extraction at this centre.

It may be as well to mention that the timber to be extracted is derived from thinnings only, sizes from 5in.-10in. diameter and 6ft.-20ft. long, and that in consequence the use of expensive machinery for exploitation was not justified.

In laying out a system of chutes within a compartment the main chute is, if possible, taken down the main valley; subsidiary chutes are then constructed on either side in a herring bone pattern, joining the main chute at distances of probably not more than 100 yards, so that eventually the whole area to be exploited is served by a system of chutes. Naturally differently situated compartments require a different treatment in layout but the ideal to be aimed at is to have as much of the area served by the chutes as possible so as to obviate the necessity for labourers having to carry logs any distance. It has been found most satisfactory to use mules for dragging logs from their place of felling to the side of the chutes. Where necessary the chutes may be curved by a slight excavation of ground on the inside and banking on the outside.

In actual construction the course of the chute is laid out and the ground cleared of debris; cross pieces about 3ft. long and 3in. thick obtained from the waste tops of trees are then laid on the



Diagrammatic Sketch of Timber Chutes

de Hoek Plantation - Transvaal.

ground about 3ft. apart and two uprights of the same dimensions are hammered, sloping slightly outwards, about 6in. into the ground and about 3in. from the end of each cross piece. For the sides of the chute, waste material is again made use of and as long lengths as possible of not more than 3in. diameter at the thick end, are nailed to the uprights, two on each side. The floor of the chute consists of gum laths, nailed to the cross pieces, usually three are sufficient; they should be as long as possible and not more than 1in.-1½in. at the thick end. The laths are placed thick end down the slope and the top end is taken under a cross piece and into the ground. In actual practice it has been found unnecessary to nail the laths to each cross piece, alternate ones being quite sufficient. Nails required are 6in. for the side rails and 3in.-4in. for the laths.

These chutes are of a very temporary nature as the pine timber of which they are constructed soon rots and new chutes must therefore be constructed whenever a compartment is thinned.

It has been suggested that the pine timber used in their construction be creosoted, thus prolonging their period of usefulness, but it is felt that if a really permanent chute is required many modifications will be required in the design so as to accommodate larger logs.

The grades on which the chutes are laid out are anything from 8° upwards—grades lower than this are not sufficient to enable the logs to overcome their initial inertia. Where, however, a long chute begins with a steep down grade, the initial velocity attained by the log will be enough to carry it over a comparativtly level grade before the next down grade is encountered. In very dry weather, due to increased friction, even grades of 8° may not be sufficient to carry logs to lower levels and in this case the application of old motor oil or even water, to the crosspieces has been found to be effective. On very steep grades on long lengths of chutes, it is very often necessary to check the speed of the logs. A very simple and efficient brake may be constructed by hinging one end of a log to a crosspiece above the chute, the other end of the log resting in the chute itself at a lower level; thus logs travelling down the chute have their velocity checked by having to lift and pass under the end of the hinged log.

As regards cost, about 5 labour units are employed per 100 yards plus 3/- for nails. After the course of the chute has been decided upon, it has been the practice to put three experienced natives on to its construction and about 80 yards are completed in one day.

A further modification of the chute principle has been devised by Forester Botha in his portable timber chutes. A glance at their diagrammatic representation will serve to show how they are constructed. The monkey rope used for the crosspieces and on to which the laths are nailed can readily be replaced by two pine uprights. These 12ft.-15ft. lengths of chutes are light and can easily be carried by two natives. They are used for short steep slopes and distances of 15-100 yards, where it would not be worth while to construct a fixed chute.

CORRESPONDENCE.

WEANING THE NATIVES FROM THE NATURAL FORESTS IN THE NATIVE TERRITORIES.

To the EDITOR.

Sir,

In his Historical Sketch of the Development of Forestry in South Africa, published in the last issue of this Journal, I notice that Mr. King indicates that Mr. Heywood inaugurated the policy of wattle plantations to save the forests of the Native Territories from destruction, in 1898. This is not quite correct.

It appears that this policy was first mooted by Count de Vasselot in 1890, and was referred to in the Annual Reports of the Forest Department for 1890, 1892, and 1893. However, no action whatever was taken, and when I was appointed District Forest Officer at Kokstad in 1892, I was quite unaware of these suggestions.

It was while undergoing training at Coopers Hill that I first realised the possibility of saving the native forests by means of wattle plantations, and immediately wrote to the then Conservator, Mr. Henkel, urging him to lose no time in starting such plantations; at the same time indicating the lines on which the work should be done. Knowing that our funds for experimental planting were infinitesmal, I also suggested that he should enlist the interest of the Chief Magistrate, the late Sir Henry Elliot, in the scheme, so that the Native Council, who had ample means, should also adopt the principle.

These suggestions were acted upon, and when I returned to South Africa at the end of 1895, three plantations had been started by the Department and three by the Native Council. On my return, after acting as Conservator for about four months during Mr. Henkel's indisposition, I was transferred from Kokstad to Butterworth. Mr. Caplin, who had been acting District Forest Officer there for a while, was then seconded to the Native Council as Superintendant of their wattle plantations.

Owing to the prejudices displayed by the natives who maintained that wattles and poles of exotic species would be useless for their purposes, every effort to obtain ground in native locations for the purpose was stoutly opposed by them on the ground that every bit of their ground was required for cultivation and grazing. I then wrote an article on the subject, describing the hopeless condition of the forests and their ultimate destruction unless measures were taken to prevent it, in the hope of enlisting the support of the local magistrates who had more influence over the natives than the Department. Incidentally I also

referred to the serious danger from encroaching sand drifts, due to the gradual destruction of scrub forests along the coastal belt. This article was published in a small monthly magazine, I forget its name and whether a government or private publication, which circulated in those parts at the time. This had the effect of several magistrates granting the Department land for plantations on their magisterial reserves. Among these were Butterworth, Kentani, Kokstad, Mount Frere, Cofimvaba, Tsolo, Umtata and Cala. At that time the total vote for plantation work in the whole of the Territories was £1,000 and it was a hard struggle to keep going. I was also asked to inspect the Native Council plantations, and to report on them. I did so, and copies of my report should be on the files of the district forest officer, Butterworth, and of the Bunga, though the latter has probably been forgotten and buried ages ago. The same remarks apply to the magazine article above referred to.

An old adage says "you can bring a horse to water but you can't make him drink," a saying which proved very appropriate in our case. Although we only asked a nominal fee for our material, the natives would have nothing to do with it. I then presented some of the headmen and magistrates with sufficient material to build a hut each as a demonstration, so that they could form their own opinion of the results. In this way it gradually began to soak into their minds that the plantation material was every bit as good as that from the natural forests, in fact a great deal better. Instead of having to spend weeks in running about distant and scattered patches of forest, already denuded of good material, to pick up an odd crooked stick here and there, they were able in one day to obtain a whole wagon load of beautifully straight wattles and poles from a centrally situated plantation, which proved even more serviceable and just as lasting as anything they could find in the forests. When these advantages had at last soaked into the slow native mind, instead of objecting to give up the comparatively small bits of land needed in their locations, many headmen came begging me to establish plantations in their locality. The next difficulty we had to contend with was to induce a somewhat niggardly government to provide sufficient funds to extend the good work. By that time I was transferred to the Orange River Colony, and cannot speak of subsequent events. But it seems clear that the action taken at a most critical stage in those early days had the effect of saving the remnants of the native forests from utter destruction, and enabled subsequent generations of foresters to build up and improve them for all posterity.

When Mr. Heywood was appointed Conservator of Forests in the Territories, thirteen such plantations had already been established or inaugurated.

Yours faithfully,

K. A. CARLSON.

Pretoria Club,
Pretoria.
11th March, 1939.

MINING TIMBER.

To the EDITOR.

Sir,

Since the timber industry, like many other industries in the Union, ought to be regarded as a part of the general mining industry which absorbs the greatest proportion of the native grown timber, it would appear that there should be a closer contact between the producer and buyer, as the most suitable timbers could then be grown and a knowledge of the sizes required—of paramount importance—could be obtained.

There seems to be great doubt among timber growers as to the most suitable timber, chiefly due to the conflicting opinions expressed by many mines. It therefore appears to be a question to be dealt with as a whole by some central authority. At the present time *Eu. saligna* is probably the most popular timber among growers, due to its high productivity in a comparatively short time, but only a few years ago some of the mining groups were inclined to exclude it from their contracts. Had this been done many timber growers would have been ruined, and it is felt that the mining industry ought to settle the question of the suitability of this timber once and for all. It would of course be difficult for them to lay down hard and fast rules, but some indication as to what timbers should be planted would be of the greatest assistance to timber growers all over the country.

The producer and buyer are each in the dark as concerns the others' difficulties, as the following endeavours to show.

In the case of a mine which uses exclusively 8ft. x 5 to 7in. poles there is a large surplus of timber left over in the plantations, and a test made in an average plantation shows the following results: 55.39 per cent. by volume of the timber consisted of poles 8ft. x 5 to 7in., 2.65 of timber 8in. upwards and the remaining 41.96 per cent. of poles 4in. and under. This means that 44.61 per cent. of the timber must be disposed of elsewhere, probably at a lower price and the price of the 5 to 7in. timber must necessarily be higher to maintain the average than would be the case if a sale was assured for all sizes. For comparison the percentage volumes of various 8ft. x inch classes, with the planting espacement are given below.

	9 x 9 saligna	6 x 6 saligna	10 x 10 saligna
8 x 2	6.51	11.84	6.80
8 x 3	14.43	24.17	17.29
8 x 4	21.02	26.46	25.36
8 x 5	22.13	21.63	24.23
8 x 6	20.25	11.64	14.70
8 x 7	13.01	3.35	6.43
8 x 8 up	2.65	.91	5.19
	100.00	100.00	100.00

A study of these figures will show the difference in the sizes of the timber obtained by varying the espacements. With a better knowledge of the mines' requirements over a period of years, the timber grower could regulate his planting to suit the demand, and

by a better understanding of the difficulties inherent in timber growing a mining group could probably so dispose its requirements as to avoid undue loss from higher prices.

A revolutionary development in timbering during the last few years has been the mat-pack, but there is no standardisation of timber and sizes of packs. Some mines prefer wattle, others gum. While it is realised that wattle is probably more durable, untreated, than the various gums it would seem that there are cases where gum would be more suitable and more easily handled due to its lower weight per cubic foot. The timber costs of other mines again would possibly be reduced were they to use wattle in the more permanent working places.

Instances of the lack of knowledge on the part of the mines could be quoted. At one time some mining authorities were of the opinion that a shorter type of mat-pack could be produced from branchwood, but actually very few plantation trees in South Africa produce utilisable branchwood. When mat-packs were first adopted the sizes used were regarded as waste from the heavier timber then used, but with the increased demand for mats certain sizes, as shown above, became the main product.

I understand that the Exchange Yard maintains a research department, mainly for experiments on timber preservation, but fuller research is needed and more understanding of the timber industry as a whole. For instance, the fact that transport is difficult in the rainy season is often overlooked. More co-operation would probably avoid shortages on the mines during this period, and so save them many delays. The railways, too, are not always able to supply trucks and timber urgently required is often held up. On the other hand, the difficulties experienced by the mines are not always appreciated. A rockfall may occur and retimbering use up the mine surplus. The supplier may wonder why he has to deliver so urgently.

There should be some standardisation of methods of payment as well. A price per ton is unfair to the suppliers of the lighter timbers and it is seldom realised that more timber comparatively is supplied than in the heavier woods. A price per pole or piece would place all on an equal basis, the difference in railage costs to be made up in some way by increased durability: the heavier woods are usually more durable.

With the above in mind I feel that the establishment of a "Timber Advisory Bureau," representing the mines, sawmills and timber growers would be of the greatest assistance to all, the Bureau to collect statistics of all kinds relating to mining timber and pass on to each the information gained thereby. The Bureau could also act as a channel through which complaints could be discussed and the various trends of the timber industry controlled to the best advantage of the buyers and sellers.

Yours faithfully,

G. L. GUY,
B.Sc. For. (Edin.)

Politsi,
Transvaal.
14th February, 1939.

REVIEWS

ANNUAL REPORT OF THE DIVISION OF FORESTRY FOR THE YEAR ENDED 31st MARCH, 1938. Government Printer, Pretoria, 1938. Price 2/-.

Conservation in its widest sense is the keynote of this report. In his introduction, the Secretary for Agriculture and Forestry points out the varied directions in which the Forest Service has espoused the cause of conserving the natural resources of the land. Besides directly forestal activities, it has had to deal, both in the past and to-day, with the arrestment of erosion, drifting sand, and uncontrolled burning of veld, and with the improvement of the areas thereby stabilised. The acquisition of catchment land for maintenance of the water supplies of towns, villages, and farm lands, was continued by the addition of over 100,000 acres to the forest estate. The scope of research into the influence of afforestation on local natural resources has been expanded by the initiation of a forest influences research station at Cathkin Peak, on the Drakensberg, where observations on these influences in summer rainfall areas will valuably supplement those previously initiated at Stellenbosch. Experiments initiated at Kruisfontein, in the Midlands, demonstrate a surprisingly low percentage of run-off under both natural and artificially established vegetative cover compared with total precipitation. Some indication of the degree of slope of the areas concerned would have added value to the information presented.

The fencing off of natural forests in the Transkei and in the Eastern Province, started some years ago, is said to be justifying itself, and is still proceeding. Fencing was undertaken by the Division also in connection with foot-and-mouth disease, 42 miles having been completed on the Portuguese border between Ressano Garcia and Swaziland.

Under utilisation and marketing some interesting axioms are laid down. For instance, in a discussion of alleged State competition with private enterprise, referring to timber importing interests, while competition is not disclaimed, it is stated that it "need continue only so long as they (the importers) neglect the local product." The contention that proximity to plantations should not procure for some farmers privileges over their less favourably situated fellows or over urban communities, in matters affecting their technical management, none will dispute. Nor can objection be raised to the principle that "the local price of timber and timber products must be fixed on the basis of world prices." These incursions into the realm of economics are reassuring, indicating, as they do, that current management measures are being planned with full realisation of the State's responsibilities to the eventual partakers in a steadily growing natural resource.

The subject matter of an admirable little essay under the heading "The Place of Wood in the National Economy," which all our readers are strongly advised to read, is summed up in the following trenchant sentence :—

> The wide variation, the world over, in the *per capita* consumption of timber, which is roughly proportional to the extent of supplies at hand, indicates that there is practically no such thing as "saturation point" in the use of timber.

Artificial afforestation is progressing steadily. At the close of the report period, 339,242 acres had been established; 14,451 acres, or only 426 acres below the previous year's quota, being planted and sown during the period. The slight shortfall was due chiefly to labour shortages and unfavourable planting conditions in certain regions, which also affected the Division's sale of transplants. There still remain some 300,000 acres, unutilised, in the forest estate, and when this is eventually brought to a producing stage, a mill capacity exceeding 100 times that of the largest individual plant now operating in the country will be required to deal with the combined produce. It is estimated that when that stage is reached, the industry will be supporting over 100,000 persons.

It is encouraging to note that the Division's faith in the future of preserved products, particularly creosoted poles, has been justified. This is testified to by the fact that, in spite of large outputs from other State plants in various parts of the country, the equipment at the Forest Products Institute, at Pretoria West, was kept running at full pressure to meet current demands.

The roll of species that are coming into use for various specific purposes as the result of work at the Forest Products Institute, is increasing. Thus we find various Eucalypts in demand by the Postal Authorities for telephone cross arms. Poles of various species of Pine are taken by the same authority now to supplement Eucalypt species for telephone poles. The demand for Karri flooring is greater than the supply; while Yellowwood has now a very definitely established place in the printing trade.

The forest research section provides interesting reading, but it should be read in its entirety. Space only allows reference here to certain experiments that are being conducted in regard to the vegetative reproduction of conifers. Success in New Zealand with *Pinus insignis*, and the appearance on the market of certain growth hormones, alleged to induce rapid rooting in refractory species, indicate important possibilities in this direction. The project is only in its initial stages, but should it meet with success, its practical applicaton will be of far-reaching importance. Not only will it render growers independent of seed supplies of the rarer species, but it will facilitate unmodified perpetuation of the best strains found in existing stands.

The wattle industry is reaping the benefits of increased prices, and even labour shortages and inclement weather conditions, although conducing to a decrease in volume of bark and extract exported, failed to curtail the corresponding revenue, which exceeded that for the previous year by £76,110.

The only set back recorded in this otherwise encouraging and certainly interesting report affects the pulp and paper industry, the initiation of certain commercial projects in which was hampered by questions of water rights and stream pollution apprehensions, which no doubt will eventually be overcome. A project for the manufacture of paper from wheat straw is, however, nearing the producing stage on the Rand.

Reserves aggregating in area to over 55,000 acres, valued at £257,000, were transferred from control of the Railway Administration to that of the Central Government; and for purposes of comparing expenditure with revenue, this negotiation must be allowed for. On this basis, total normal expenditure of £522,754, and total revenue of £185,685 represent increases of 6.3 and 8.5 per cent., respectively, over the corresponding figures for the previous year. Approximately 36 per cent. of the year's expenditure was met by revenue, which at this stage in the execution of the Division's programme, is quite encouraging.

PUBLICATIONS RECEIVED

Copies of the following publications have been received with thanks :

THE ROYAL SCOTTISH FORESTRY JOURNAL. Parts 1 and 2, vol. 52, 1938.

ZEITSCHRIFT FÜR WELTFORSTWIRTSCHAFT. Vol. vi. Part 2. November, 1938.

DE BOOMSOORTEN, deur G. Houtzagers en M. de Koning. Uitgawe van de Nederlandsche Heidemaatschappij.

VAN BOSSCHEN EN BOOMEN, 2nd. druk. Uitgawe van die Nederlandsche Heidemaatschappij.

TIJDSCHRIFT DER NEDERLANDSCHE HEIDEMAATSCHAPPIJ, aflewering 10, 11, and 12 van 1938, en 1 van 1939.

SYMPOSIUM ON THE NEED FOR THE CONSERVATION OF SOUTH AFRICA'S NATURAL RESOURCES AND FEATURES OF SCIENTIFIC INTEREST AND IMPORTANCE (Reprint from the *South African Journal of Science*.

AUSTRALIAN FORESTRY. Vol. iii, No. 2, December, 1938.

THE NEW ZEALAND JOURNAL OF FORESTRY. Vol. iv, No. 3. 1938.

A FORESTRY TOUR IN 1937, By L. Chalk, M.A., D.Phil. Imperial Forestry Institute Paper No. 16. Oxford 1939. Price 2/6.

The

Journal of the South African Forestry Association

October

PUBLISHED BY THE ASSOCIATION
April and October

Die

Tydskrif van die Suid-Afrikaanse Bosbouvereniging

Oktober

UITGEGEE DEUR DIE VERENIGING
April en Oktober

No. 3. 1939
PRETORIA

SOUTH AFRICAN FORESTRY ASSOCIATION

Patron:

HIS EXCELLENCY THE GOVERNOR-GENERAL,
THE RIGHT HON. SIR PATRICK DUNCAN, G.C.M.G., K.C.

President:

COLONEL THE HONOURABLE DENEYS REITZ, M.P.

Vice-Presidents:

COLONEL THE HONOURABLE W. R. COLLINS, M.P., D.T.D., D.S.O.
HANS MERENSKY, DR.ING.H.C., D.SC.
H. J. VAN DER BIJL, PH.D., D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.
P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.
C. E. LEGAT, C.B.E., B.SC.

OFFICERS:

Chairman: J. D. KEET, DIP.FOR., M.SC. (HON.)
Vice-Chairman: H. A. READ, F.S.A.A.
Hon. Editor: J. M. TURNBULL, DIP.FOR.
Hon. Secretary-Treasurer: E. K. MARSH, B.A.

Executive Committee:

J. D. KEET, DIP.FOR., M.SC. (HON.), (*Chairman*)
H. A. READ, F.S.A.A. (*Vice-Chairman*)
D. R. DE WET, B.SC., L.I.K.B. (WAG.)
CONNEL O'C. MAGGS, B.A., B.SC.
PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.
J. M. TURNBULL, DIP.FOR. (*Editor*)
E. K. MARSH, B.A., (*Sec.-Treas.*)

ANNUAL REPORT FOR THE YEAR ENDED MAY 31st, 1939.

The Association was established at a meeting held in Pretoria on May 13th, 1938, and the progress made during the first year was satisfactory.

His Excellency the Governor-General honoured the Association by extending his patronage to it. Colonel the Hon. Deneys Reitz accepted the office of President and Colonel the Hon. W. R. Collins, the Hon. S. P. Bekker, Dr. Hans Merensky, Dr. P. R. Viljoen and Dr. H. J. van der Byl accepted office as Vice-Presidents.

The Association regrets to record the death of the Hon. S. P. Bekker shortly after his acceptance of office.

The office of Chairman was held by Mr. J. D. Keet during the year.

The membership of the Association at the close of the year was as follows :—

Life Members	5	
Full Members	144	
Associate Members ...	128	
Affiliated Members ...	32	(having 39 nominees)
Honorary Officers or Members	5	
Total	321	

There is still great scope for increasing the membership of the Association, and all members are urged to bring the objects of the Association to the notice of their friends interested in these objects and to endeavour to enrol them as members.

The funds of the Association sufficed for the publication of the first two issues of the Journal but were insufficient to cover the cost of any further activities.

The accounts submitted with this report show that the income for the year was £403 14s. 0d. and the expenditure £380 8s. 6d. leaving an excess of income over expenditure of £23 5s. 6d.

Two numbers of the Journal were published during the year and received very favourable notices both at home and abroad. The number of articles offered to the Editor was much in excess of the number which it was possible to include, as the funds available were insufficient to cover the cost of larger Journals.

The Association is much indebted to its executive committee and its editorial committee for their willing and able assistance during the past year, but our thanks are due particularly to the Secretary-Treasurer, Mr. W. E. Watt, who had to bear the major share in launching the Association, and to the Editor, Mr. J. M. Turnbull, for the high standard attained for the Journal, which we are assured will be maintained. We also have to thank those who have submitted contributions to the Journal and those of our members who have enlisted others to become members.

Mr. A. N. White consented to act as Honorary Auditor and his services are gratefully acknowledged.

(Sgd.) J. D. KEET,
Chairman.
26th July, 1939.

FIRST ANNUAL GENERAL MEETING.

HELD AT SOMERSET HOUSE, VERMEULEN STREET, PRETORIA, AT 8.30 P.M., ON THE 26TH JULY, 1939.

Attendance : Twenty members were present.

1. The notice convening the meeting was read.
2. The Chairman, Mr. J. D. Keet, then welcomed those present and offered the apologies of Dr. Viljoen, Secretary for Agriculture and Forestry, for his inability to attend. He hoped that future meetings of the Association would aim at more than the transaction of formal business and suggested that Annual Meetings might be combined with some social function, and that they might sometimes be held at other centres than Pretoria in order to enable more members to attend. The Chairman stressed the need for enrolling new members, particularly amongst those concerned with timber and other products of the forests and amongst those interested in the many indirect benefits resulting from forests. He cited instances in which the granting of freedom of entry

to forests and forest reserves for recreational purposes had resulted in mutual benefits to the visitors and those in control of the forests and plantations. The Chairman advocated the need for bringing Forestry and allied subjects to the notice of the public through the press. He referred to the high standard attained by the Association's Journal as evidenced by favourable reviews and drew attention to the need for more contributions of a popular nature. With reference to one of the objects of the Association, namely the protection of the natural flora, he intimated that the Forestry Division would from this year onwards take part in wild flower shows at Caledon and Ceres, with the objects of demonstrating one of the important benefits of protection of the mountains and of stimulating interest in the natural flora. The Chairman also drew attention to the coming meeting of the Third International Forestry Conference at Helsinski and that of the Fifth Empire Forestry Conference in India to be held in 1940 and mentioned the benefits which resulted from the Fourth Empire Forestry Conference held in South Africa in 1935.

3. The Secretary (Mr. W. E. Watt) read the minutes of the inaugural meeting which were confirmed by the meeting and approved by the Chairman.

4. At the Inaugural Meeting held on May 13th, 1938, the following resolution was proposed by Mr. O'Connor, seconded by Dr. Craib and passed unanimously :—

> That the drafting of the Constitution consistent with the resolutions adopted be left to the Executive Committee of the Association and that the Committee be empowered to act under the Constitution so drafted until it is confirmed at the next general meeting.

In terms of the above-mentioned resolution Mr. Jurriaanse now proposed that article VII, section 2, of the constitution be amended to provide for both an English and Afrikaans title to the Journal, or that the Journal be given a Latin or other generally acceptable title.

Considerable discussion of this proposal ensued.

Mr. O'Connor proposed that the section in question be altered to read as follows : The Journal shall be called "Bosbou, the Journal of the South African Forestry Association." Mr. Maggs seconded this proposal.

Dr. Craib put forward an amendment that the section under discussion be altered to read : The Journal shall be called "The Journal of the South African Forestry Association" and "Die Tydskrif van die Suid-Afrikaanse Bosbouvereniging." This proposal was seconded by Ir. de Wet.

On being put to the vote, Dr. Craib's amendment was carried by 12 votes to 5.

Mr. Turnbull, seconded by Mr. O'Connor, proposed the addition of the words "Forest Products" before the words "Wood Utilization" in Article II, object 3. The proposal was carried unanimously.

Dr. Craib, seconded by Ir. de Wet, proposed the acceptance of the constitution as drafted by the Executive Committee, but subject to the amendments mentioned above. The acceptance of the constitution in its revised form was carried unanimously.

5. The Chairman then read the annual report of the Association and presented the balance sheet for the past year.

6. In terms of article IV, section 3, of the constitution the following officers were declared elected :

Chairman : Mr. J. D. Keet, unopposed.
Vice-Chairman : Mr. H. A. Read, unopposed.
Hon. Editor : Mr. J. M. Turnbull, unopposed.

and the following elected by letter ballot :—

Hon. Sec. Treasurer : Mr. E. K. Marsh.
Committee Members : Mr. C. O'C. Maggs, Prof. J. F. V. Phillips, Ir. D. R. de Wet.

In terms of article IV, section 3 of the constitution, the Chairman will hold office for 3 years, the Vice-Chairman and Secretary-Treasurer for 2 years and the Editor for 1 year. In terms of the same section, one Committee Member elected will hold office for 3 years, one for 2 years and one for 1 year.

It had been decided at a meeting of the Executive Committee held on June 2nd that the Committee Member obtaining the greatest number of votes in the letter ballot would hold office for 3 years, the member obtaining the next highest number of votes would hold office for 2 years and the member obtaining the third highest number of votes would hold office for one year. Ir. de Wet obtained the third highest number of votes and was declared elected for one year. Mr. Maggs and Prof. Phillips obtained the same number of votes and, on the meeting being asked to decide which of these gentlemen would serve for 3 years and which for 2 years, it was resolved that Prof. Phillips be elected for a period of 3 years and Mr. Maggs for a period of 2 years.

7. The Chairman informed the meeting that the question of publishing the Journal quarterly instead of bi-annually had received attention at a meeting of the Executive Committee held on June 2nd. The Executive Committee had attempted to overcome the difficulty of lack of funds by approaching prominent persons and bodies for donations and Mr. Read had been successful in obtaining a donation of £100 from the Chamber of Mines. This donation, supplemented by revenue from the sale of reprints, would, however, permit only the size of the next two or possibly three numbers of the Journal to be increased. In reply to the Chairman's plea for proposals for increasing the funds and membership of the Association, Mr. Read said that further efforts should be made to obtain donations and he advocated increasing the popular appeal of the Journal and supplying members with enrolment forms for the purpose of enrolling new members.

Dr. Craib suggested that the Division of Forestry be requested to extend to members of the Association the privileges granted to members of the Mountain Club of South Africa.

8. The Chairman seconded by Mr. Watt, proposed the following resolution which was carried with acclamation: That the Transvaal Chamber of Mines be accorded a hearty vote of thanks for its generous donation of £100 towards the funds of the Association.

9. Mr. Turnbull, seconded by Dr. Craib, proposed a recommendation to the Executive Committee to the effect that a list of members of the Association should be published in the Journal at intervals as funds permit. The proposal was accepted by the meeting.

10. Mr. Jurriaanse proposed that the table of contents, list of officials, and notices should be published in the Journal in both English and Afrikaans, and that parts of the Editorial Notes of purely local interest and, as far as possible, short summaries of important articles should be published in the second language. Mr. de Wet seconded the proposal which was agreed to by the meeting.

11. The meeting also agreed to a recommendation to the Executive Committee to consider the feasibility of combining some social function or excursion with the Annual General Meeting.

12. Ir. Malherbe, seconded by Mr. Loock, proposed a vote of thanks to the Executive Committee for its work during the past year. The proposal was carried unanimously.

13. Mr. Schonland, seconded by Mr. Keet, proposed a special vote of thanks to Mr. Watt for the services he had rendered to the Association. The proposal was carried unanimously.

The meeting closed at 10.40 p.m.

E. K. MARSH,
Hon. Secretary-Treasurer.

28th July, 1939.

SOUTH AFRICAN

INCOME AND EXPENDITURE ACCOUNT

EXPENDITURE.

To Publication of Journal and Reprints	£369 6 7		
Add amount due	5 16 11		
	£375 3 6		
Less amount paid in advance	14 1 6	£361 2 0	
To Stationery and Office Sundries			6 11 6
To Postage Stamps			9 7 6
To Bank Charges			3 7 6
To Balance (Surplus of Income over Expenditure for the year)			23 5 6
			£403 14 0

BALANCE SHEET AS

LIABILITIES.

Subscriptions paid in advance—			
Life Members	£73 10 0		
Other Members	8 17 6	£82 7 6	
Sundry Creditors			5 16 11
Capital Account (Surplus for year as per Income and Expenditure Account)			23 5 6
			£111 9 11

I hereby certify that I have examined the books and accounts of the Account and Balance Sheet are a true and correct statement of the Association's

FORESTRY ASSOCIATION

FOR THE YEAR ENDED 31st May, 1939.

INCOME.

By Annual Subscriptions—		
Life Members	£78 15 0	
Less paid in advance	73 10 0	
Proportion for year		£5 5 0
Other Members	246 11 0	
Add amounts due	3 12 0	
	250 3 0	
Less amounts paid in advance	8 17 6	241 5 6
By Advertisements	27 10 6	
Add amounts outstanding	18 9 6	46 0 0
By Sales of Journals and Reprints		111 3 6
		£403 14 0

AT 31st MAY, 1939.

ASSETS.

Cash in hand	£75 6 11
Payment in advance	14 1 6
Sundry Debtors	18 9 6
Subscriptions in arrear	3 12 0
	£111 9 11

South African Forestry Association and that the above Income and Expenditure position.

A. N. WHITE.

29th July, 1939.

SUID-AFRIKAANSE BOSBOUVERENIGING

Beskermheer:

SY EKSELLENSIE DIE GOEWERNEUR-GENERAAL,
DIE HOOGEDELAGBARE SIR PATRICK DUNCAN,
G.C.M.G., K.C.

President:

DIE EDELAGBARE KOLONEL DENEYS REITZ, L.V.

Vise-Presidente:

DIE EDELAGBARE KOLONEL W. R. COLLINS, L.V., D.T.D., D.S.O.
HANS MERENSKY, DR.ING.H.C., D.SC.
H. J. VAN DER BIJL, D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.
P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.
C. E. LEGAT, C.B.E., B.SC.

AMPSDRAERS:

Voorsitter: J. D. KEET, DIP.FOR., M.SC. (ERE.)
Vise-Voorsitter: H. A. READ, F.S.A.A.
Ere-Redakteur: J. M. TURNBULL, DIP.FOR.
Ere-Sekretaris-Tesourier: E. K. MARSH, B.A.

Uitvoerende Komitee:

J. D. KEET, DIP.FOR., M.SC. (ERE.), (*Voorsitter*)
H. A. READ, F.S.A.A. (*Vise-Voorsitter*)
D. R. DE WET, B.SC., L.I.K.B. (WAG.)
CONNELL O'C. MAGGS, B.A., B.SC.
PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.
J. M. TURNBULL, DIP.FOR. (*Ere-Redakteur*)
E. K. MARSH, B.A. (*Ere-Sek.-Tes.*)

JAARVERSLAG VIR DIE JAAR GEËINDIG 31 MEI, 1939.

Die Vereniging is in die lewe geroep deur 'n vergadering wat te Pretoria op 13 Mei 1938, gehou is. Die vooruitgang wat gedurende die eerste jaar gemaak is was bevredigend.

Sy Eksellensie die Goewerneur-Generaal het die Vereniging vereer deur sy welwillendheid om as beskermheer op te tree. Die Edelagbare Kolonel Deneys Reitz het die presidentskap aangeneem, en die Edelagbare Kolonel W. R. Collins, Sy Edele S. P. Bekker, Dr. Hans Merensky, Dr. P. R. Viljoen en Dr. H. J. van der Byl het die amp van Vise-Presidente aangeneem.

Die Vereniging betreur die afsterwe van Sy Edele S. P. Bekker kort nadat hy hierdie amp aanvaar het.

Mnr. J. D. Keet het gedurende die jaar as voorsitter opgetree.

Die lidmaatskap van die Vereniging was aan die end van die jaar as volg :—

Lewenslange lede	5	
Volle lede	144	
Geassosiëerde lede	128	
Geaffiliëerde lede	32	(met 39 benoemde lede).
Honorêre Ampsdraers of Erelede	5	
Totaal	321	

Die ledetal van die Vereniging kan nog baie uitgebrei word, en by alle lede word daarop aangedring om die strewe van die Vereniging onder die aandag van hulle vriende wat hierin mag belangstel, te bring en hulle as lede te probeer werf.

Die fondse van die Vereniging was voldoende om die eerste twee uitgawes van die Tydskrif te publiseer maar was ontoereikend om die koste van enige verdere werksaamhede te dek.

Die balansstaat wat met hierdie verslag ingedien word, toon aan dat die inkomste vir die jaar £403 14s. od. bedra het; die uitgawe was £380 8s. 6d., sodat die inkomste £23 5s. 6d. meer was as die uitgawe.

Twee nommers van die Tydskrif is gedurende die jaar uitgegee en daar is beide plaaslik en oorsee baie gunstig oor opgemerk. Die aantal artikels wat aan die Editeur aangebied is het die aantal wat werklik geplaas kon word, ver oortref, aangesien die beskikbare fondse onvoldoende was om die koste van lywiger Tydskrifte te dek.

Die Vereniging is veel verskuldig aan sy Uitvoerende Komitee en sy Redaksie Komitee vir hul welwillende en bekwame medewerking gedurende die afgelope jaar, maar ons is veral dank verskuldig aan die Sekretaris-Tesourier, Mnr. W. E. Watt, wie die grootste spit moes afbyt om die Vereniging van stapel te laat loop, en ook aan die Editeur, Mnr. J. M. Turnbull, vir die hoë standaard wat die Tydskrif bereik het. Ons is oortuig dat dieselfde standaard ook in die toekoms gehandhaaf sal word. Ons moet ook diegene bedank wat bydraes vir die Tydskrif gelewer het, asook die lede wat daarin geslaag het om nuwe lede te werf.

Mnr. A. N. White het toegestem om as Ere-Ouditeur te dien, en sy dienste word met dank erken.

(Get.) J. D. KEET,
Voorsitter.

26 Julie, 1939.

EERSTE JAARLIKSE ALGEMENE VERGADERING GEHOU TE SOMERSET HUIS, VERMEULEN-STRAAT, PRETORIA, OM 8.30 N.M. OP 26 JULIE, 1939.

Opkoms : Daar was twintig lede teenwoordig.

1. Die kennisgewing waarvolgens die vergadering bymekaar geroep is, is gelees.
2. Die Voorsitter het die persone wat teenwoordig was welkom geheet, en die verontskuldiginge aangebied van Dr. Viljoen, Sekretaris van Landbou en Bosbou, omdat hy nie aanwesig kon wees nie. Hy het gehoop dat toekomstige vergaderings van die Vereniging daarna sou strewe om iets meer te verrig as slegs die behandeling van formele besigheid en het aan die hand gegee dat Jaarvergaderings met een of ander sosiale funksie gepaard moet gaan. Dit kan miskien soms ook op ander plekke behalwe Pretoria, gehou word, sodat meer lede dit kan bywoon. Die Voorsitter het nadruk gelê op die wenslikheid om nuwe

lede te werf, viral onder diegene wat betrokke is met hout en ander bosprodukte, asook onder diegene wat geinteresseer is in die baie indirekte voordele wat in bosse hulle oorsprong het. Hy het gevalle aangehaal dat waar persone vry toegang tot bosse en bosreserwes toegestaan is, dit tot die weersydse voordeel van die besoekers en diegene in beheer van die bosse en plantasies gelei het. Die Voorsitter het die wenslikheid om Bosbou en verwante onderwerpe deur middel van die pers onder die aandag van die publiek te bring, bepleit. Hy het verwys na die hoë standaard wat deur die Vereniging se Tydskrif bereik is, soos uit die gunstige kommentaar daarop geblyk het, en het die aandag gevestig op die wenslikheid vir meer bydraes van populêre aard. In verband met een van die strewes van die Vereniging, naamlik die beskerming van die natuurlike flora, het hy te kenne gegee dat die Bosbou Afdeling vanaf vanjaar gaan deelneem in die wilde-blommetentoonstellings te Caledon en Ceres, teneinde die belangrikheid vir die beskerming om van berge te demonstreer en om belangstelling in die natuurlike plantegroei aan te wakker. Die Voorsitter het ook aandag gevestig op die komende vergadering van die Derde Internasionale Bosbou Konferensie te Helsinki en die van die Vyfde Ryks-Bosboukonferensie in Indië wat in 1940 gehou sal word, en het melding gemaak van die voordele wat uit die Vierde Ryks-Bosboukonferensie wat in 1935 in Suid-Afrika gehou was, voortgevloei het.

3. Die Sekretaris (Mnr. W. E. Watt) het die notule van die Stigtingsvergadering gelees, wat deur die vergadering bevestig en deur die Voorsitter goedgekeur is.

4. Op die Stigtingsvergadering van 13 Mei, 1938, is die volgende resolusie wat deur Mnr. O'Connor voorgestel, en deur Dr. Craib gesekondeer is algemeen aangeneem :—

> Dat die opstel van die Konstitusie, ooreenkomstig die resolusies wat aangeneem is, aan die Uitvoerende Komitee van die Vereniging oorgelaat word en dat die Komitee gemagtig word om onder die Konstitusie wat aldus opgestel is te handel tot tyd en wyl dit bekragtig word deur die volgende algemene vergadering.

Volgens bogemelde resolusie het Mnr. Jurriaanse nou voorgestel dat Afdeling VII, Artikel 2, van die Konstitusie gewysig word om voorsiening te maak vir beide 'n Engelse en 'n Afrikaanse titel vir die Tydskrif, of dat die Tydskrif 'n Latynse of 'n ander algemeen aanneembare naam gegee word.

Hierdie voorstel het heelwat bespreking uitgelok.

Mnr. O'Connor het voorgestel dat die betrokke Artikel verander word om as volg te lui : Die Tydskrif sal genoem word ,,Bosbou—The Journal of the South African Forestry Association." Mnr. Maggs het hierdie voorstel gesekondeer.

Dr. Craib het 'n amendement voorgestel, naamlik dat die Artikel onder bespreking verander word tot : ,Die Tydskrif sal genoem word ,,The Journal of the South African Forestry Association" en ,,Die Tydskrif van die Suid-Afrikaanse Bosbouvereniging,", Hierdie voorstel is deur Ir. de Wet gesekondeer.

Met stemming is Dr. Craib se amendement aangeneem met 12 stemme teen 5.

Mnr. Turnbull, deur Mnr. O'Connor gesekondeer, het voorgestel dat die woord ,,Bosprodukte" toegevoeg word voor die woord ,,Houtbenutting" in Afdeling II, doel 3. Die voorstel is met algemene stemme aangeneem.

Dr. Craib, deur Lr. de Wet gesekondeer het voorgestel dat die konstitusie soos deur die Uitvoerende Komitee opgestel, onderhewig aan bogemelde amendamente, aangeneem word.

Die konstitusie is met hierdie veranderings algemeen aangeneem.

5. Die Voorsitter het daarna die Jaarverslag van die Vereniging gelees en die Balansstaat vir die afgelope jaar voorgelê.

6. Volgens Afdeling IV, Artikel 3, van die Konstitusie is dit verklaar dat die volgende ampsdraers gekies is :—

Voorsitter : Mnr. J. D. Keet, onbestrede.
Vise-Voorsitter : Mnr. H. A. Read, onbestrede.
Ere-Editeur : Mnr. J. M. Turnbull, onbestrede.

en die volgende is per stembrief gekies :—

Ere Sekretaris-Tesourier : Mnr. E. K. Marsh.

Komitee-lede : Mnr. C. O'C. Maggs, Prof. J. F. V. Phillips, Ir. D. R. de Wet.

Ooreenkomstig Afdeling IV, Artikel 3, van die Konstitusie, dien die Voorsitter vir 3 jaar, die Vise-Voorsitter en Sekretaris-Tesourier vir 2 jaar en die Editeur vir 1 jaar. Volgens dieselfde Artikel dien een van die gekose komitee-lede vir 3 jaar, een vir 2 jaar en een vir 1 jaar.

Op 'n vergadering van die Uitvoerende Komitee wat op 2 Junie gehou is, is besluit dat die komitee-lid wat die grootste aantal stemme per stembrief ontvang het vir 3 jaar sal dien, die lid wat die tweede grootste aantal stemme kry sal vir 2 jaar dien en die lid wat die derde grootste aantal stemme kry vir 1 jaar sal dien. Ir. de Wet het die derde grootste aantal stemme gekry en is dus vir 1 jaar gekose verklaar. Mnr. Maggs en Prof. Phillips het ewe veel stemme gekry en nadat dit aan die vergadering voorgelê is om te besluit wie van hierdie twee here vir 3 jaar en wie vir 2 jaar moet dien, is dit besluit dat Prof. Phillips vir 'n periode van 3 jaar en Mnr. Maggs vir 'n periode van 2 jaar gekies word.

7. Die Voorsitter het die vergadering meegedeel dat die Uitvoerende Komitee op 'n vergadering gehou op 2 Junie, oorweeg het of die Tydskrif kwartaalliks in plaas van halfjaarliks uitgegee moet word. Die Uitvoerende Komitee het die moeilikheid van gebrek aan fondse probeer uit die weg ruim deur uitstaande persone of liggame te nader vir skenkings, en Mnr. Read het daarin geslaag om 'n skenking van £100 van die kamer van Mynwese te verkry. Hierdie skenking, aangevul deur inkomste verkry deur die verkoop van herdrukke, sal egter slegs toelaat dat die omvang van die volgende twee of moontlik drie nommers van die Tydskrif vergroot kan word. In antwoord op die Voorsitter se versoek vir voorstelle om die fondse en ledetal van die Vereniging te versterk, het Mnr. Read geantwoord dat verdere pogings aangewend moet word om skenkings te kry en hy het daarop gewys dat meer aandag geskenk moet word om die Tydskrif populêr aantreklik te maak en om lede met lidmaat-vorms te voorsien vir die werf van nuwe lede.

Dr. Craib het voorgestel dat die Afdeling Bosbou versoek word om aan lede van die Vereniging dieselfde voorregte toe te staan as wat lede van Bergklub van Suid-Afrika reeds geniet.

8. Die Voorsitter, deur Mnr. Watt gesekondeer, het die volgende resolusie voorgestel wat met toejuiging goedgekeur is : Dat die Transvaalse Kamer van Mynwese 'n hartelike mosie van dank betuig word vir hul milde skenking van £100 as bydrae tot die fondse van die Vereniging.

9. Mnr. Turnbull, deur Dr. Craib gesekondeer, het voorgestel dat 'n aanbeveling by die Uitvoerende Komitee gemaak moet word, dat 'n lys van lede van die Vereniging van tyd tot tyd in die Tydskrif gepubliseer word, na gelang fondse dit toelaat. Die voorstel is deur die vergadering aangeneem.

10. Mnr. Jurriaanse het voorgestel dat die Inhoudsopgawe, lys van Ampdraers, en Kennisgewings in die Tydskrif beide in Engels en Afrikaans moet verskyn, en dat 'n gedeelte van die Redaksie aantekenings wat van plaaslike belang is, en so ver moontlik, kort opsommings van belangrike artikels in laasgenoemde taal gegee word. Ir. de Wet het die voorstel gesekondeer wat deur die vergadering aangeneem is.

11. Die vergadering het ook saamgestem dat by die Uitvoerende Komitee voorgestel moet word om die moontlikheid te oorweeg om die een of ander sosiale funksie of uitstappie saam met die jaarlikse algemene vergadering te reël.

12. Ir. Malherbe, deur Mnr. Loock gesekondeer, het 'n mosie van dank vir die Uitvoerende Komitee vir sy werk van die afgelopejaar, voorgestel. Die voorstel is aangeneem.

13. Mnr. Schonland, deur Mnr. Keet gesekondeer, het 'n spesiale mosie van dank aan Mnr. Watt voorgestel vir die dienste wat hy die Vereniging bewys het. Die voorstel is algemeen aangeneem.

Die vergadering is om 10.40 n.m. verdaag.

(Get.) E. K. MARSH,
Ere-Sekretaris-Tesourier.
28 Julie, 1939.

SUID-AFRIKAANSE

INKOMSTE EN UITGAWE REKENING

UITGAWE.

Vir Publikasie van Tydskrif en Herdrukke	£369 6 7		
Plus bedrag verskuldig	5 16 11		
	£375 3 6		
Minus bedrag vooruit betaal	14 1 6	£361 2 0	
Vir Skryfbehoeftes en Kantoor Diverse		6 11 6	
Vir Posseëls		9 7 6	
Vir Bankkoste		3 7 6	
Op Balans (surplus van Inkomste oor Uitgawe vir die Jaar)	23 5 6		
		£403 14 0	

BALANSSTAAT SOOS

LASTE.

Subskripsies vooruit betaal deur lewenslange lede ...	£73 10 0		
Ander lede	8 17 6	£82 7 6	
Diverse Krediteure		5 16 11	
Kapitaal Rekening (Surplus vir die jaar volgens Inkomste en Uitgawe Rekening)		23 5 6	
		£111 9 11	

Ek sertifiseer hiermee dat ek die boeke en rekeninge van die Suid-Rekening en Balansstaat 'n ware en korrekte uiteensetting van die Vereniging

BOSBOUVERENIGING

VIR DIE JAAR GEËINDIG 31 MEI, 1939.

INKOMSTE.

Van Jaarlikse Subskripsie van lewenslange lede	£78 15 0	
Minus vooruit betalings	73 10 0	
Deel vir jaar		£5 5 0
Ander lede	£246 11 0	
Plus bedrae verskuldig	3 12 0	
	£250 3 0	
Minus bedrae wat vooruit betaal is	8 17 6	241 5 6
Van Advertensies	27 10 6	
Plus uitstaande bedrae	18 9 6	46 0 0
Van verkoop van Tydskrifte en Herdrukke		111 3 6
		£403 14 0

OP 31 MEI, 1939.

BATE.

Kontant op Hande	£75 6 11
Vooruit Betalings	14 1 6
Diverse Skuldenare	18 9 6
Agterstallige subskripsies	3 12 0
	£111 9 11

Afrikaanse Bosbouvereniging nagegaan het en dat bostaande Inkomste en Uitgawe se posisie is.

(Get.) A. N. WHITE.

29 Julie, 1939.

MEMBERS OF THE SOUTH AFRICAN FORESTRY ASSOCIATION.

LEDE VAN DIE SUID-AFRIKAANSE BOSBOU-VERENIGING

NOTE.—Full and Affiliated Members are shown in Roman characters.
Associate Members are shown in Italics.
**Indicates Life Membership.*
†Indicates Honorary Membership.

NOTA.—Voltydse en geaffilieerde lede word in Romynse syfers aangedui;
geassosieerde lede in qursief.
**Dui aan lewenslange lede.*
†Dui aan erelede.

Ackerman, D. P., Division of Forestry, Burlington House, Pretoria.
Ackers, C. P., Huntley Manor, Gloucester, England.
Acme Box Factory, P.O. Box 1183, Durban.
Adams, Mrs. E. V., Weltevreden, Waterkloof, Pretoria.
Albertze, J. H., Forest Station, Kloof Nek, Capetown.
Albu, Sir George, P.O. Box 1242, Johannesburg.
Andrews, E. T. E., P.O. Box 118, Barberton.
Arderne, Scott & Thesen Ltd., P.O. Box 48, Capetown.
Ashton, J. P., P.O. Box 15, Ficksburg.
Bachrich, J. L., 263 Regent Street, London. W.1.
Badenhorst Combine, P.O. Umfolozi.
Ballenden, S. St. C., Division of Forestry, Pietermaritzburg.
Barnard, F. A., Weza Forest Station, Harding.
Barnard, J. A., Division of Forestry, Graskop.
Barnard, J. H. C., Lottering Forest Station, P.O. Coldstream.
Bayer, F. A. H., P.O. Box 27, Stanger.
Bedingfeld, F., P.O. Box 22, White River.
Bekker, C. T., Division of Forestry, Bloemfontein.
Berning, F. S., P.O. Box 11, Kokstad.
Bethlehem, L., P.O. Box 685, Johannesburg.
Betton, E. A., nominee of Broedersdraai Sawmills.
Biggs, C. W., P.O. Box 39, Pietermaritzburg.
Blom, L., corner Mitchell & Church Streets, Riversdale.
Boksburg Town Council, P.O. Box 215, Boksburg. *Nominee* : Superintendent of Parks.
Boocock, J. J., 3 Links Road, Pinelands, Capetown.
Boshoff, J. A., Fort Cunynghame Plantation, P.O. Dohne.
Boshoff, W. H., Pan Plantation, P.O. Pan.
Botanical Society of South Africa, P.O. Box 267, Capetown.
Botha, P.A., Saasveld Forest School, George.
Botha, W. M. (Jnr.), Division of Forestry, Louis Trichardt.
Bourke, M., P.O. Box 321, Pretoria.
Bowen, J. W., nominee of Transvaal Chamber of Mines.
Bower, H. G., Division of Forestry, Pietermaritzburg.
Boxes and Shooks (Pty.) Ltd., P.O. Retreat.
Broedersdraai Sawmills, P.O. Veekraal.
Brown, T. W., Swellendam Forest Station, Swellendam.
Brunt, H. Hugo, Civil Service Club, Church Square, Capetown.
Bryson, T., P.O. Box 430, Germiston.
Burger, A. P., Witklip Forest Station, P.O. White River.
Burger, J. J., Holfontein Forest Station, P.O. Holfontein.
Burman, A. W., P.O. Box 43, Duivelskloof.
Burton R., Middleton House, Main Street, Muizenberg.
Buys, J. de B., Katberg Forest Station, P.O. Katberg.

Calf, M. J., 239 Bertha Street, Kenilworth, Johannesburg.
Canvacott (Pty.) Ltd., P.O. Box 4752, Johannesburg.
Capetown City Council, City Hall. *Nominee*: The Town Clerk.
Carlson, K. A., Pretoria Club, Vermeulen Street, Pretoria.
Ceronio, C., nominee of Rand Mining Timber Co., Ltd.
Chalkley, G. A., P.O. Box 30, White River.
Chaplin, F. G., Government Trout Hatchery, Jonkershoek, Stellenbosch.
Chase, C. C., Insizwa Forest Station, Mount Ayliff.
Clan Syndicate Ltd., Private Bag, Pietermaritzburg.
Clayton, C. H., Division of Forestry, George.
Clements, J. B. C., Zomba, Nyassaland.
Collins, L. B., Lions Glen, Amsterdam, Transvaal.
Conservator of Forests, P.O. Box 181, Belize, British Honduras.
Cooke, J., Xumeni Forest Station, Donnybrook.
Cooper, G. D., nominee of Purcell, Yallop & Everett, Ltd.
Corlett, D. F., P.O. Box 2573, Johannesburg.
Corrigall, J., P.O. Box 365, Springs.
Craib, Dr. I. J., Forest Research Section, Palace of Justice, Pretoria.
Dannemora Iron & Steel Co. Ltd., P.O. Box 5809, Johannesburg.
Davidson, R. H. B., Division of Forestry, Storms River.
Dawson, R. L., Bizana Forest Station, Bizana.
Deane, F. J., Private Bag, Howick.
de Geus, H. L., Division of Forestry, Burlington House, Pretoria.
de Klerk, G. J., Zuurberg Forest Station, P.O. Zuurberg.
de Souza, L. L., Division of Forestry, Barberton.
de Villiers, A. M., Gewaagd, P.O. Zunckels, via Winterton.
de Villiers, P. C., Division of Forestry, Knysna.
de Villiers, V., Booyskraal, Victoria West.
de Waal, P. H., Ladybrand Forest Station, P.O. Ladybrand.
de Wet, D. R., Division of Forestry, Burlington House, Pretoria.
Didring, M. F., nominee of Dannemora Iron & Steel Co. Ltd.
Dijkmans, M. A. F., Huggensweg 12, Bandoeng, Java.
Director of Parks and Gardens, Durban; nominee of Durban Corporation.
Dommissee, E. J., Division of Forestry, Sabie.
Dormehl, P. J., P.O. George.
Duff, C. E., District Forest Office, Ndola, Northern Rhodesia.
du Plessis, A. P. G., Bultfontein Forest Station, P.O. White River.
du Plessis, D. J., Izeleni Forest Station, Stutterheim.
du Plooy, G. J., Kubusie Forest Station, Stutterheim.
du Preez, J. L., Indlunkulu Forest Station, P.O. Main.
du Preez, P. E., Division of Forestry, Bloemfontein.
Durban Corporation, City Hall, Durban.
du Toit, D. K., Buxton Forest Station, P.O. Buxton.
Dwyer, E. B., Gordon Terrace, Kingwilliamstown.
Eckbo, N. B., Forest Products Institute, Ketjen Street, Pretoria West.
East London Municipality, P.O. Box 134, East London. *Nominee*: Chairman, Beach and Parks Committee.
Egling, F. G., Ntsubane Forest Station, P.O. Lusikisiki.
Ellis, E. W. C., Gouna Forest Station, Knysna.
Emett, L. S., Kologha Forest Station, Stutterheim.
Erasmus, G. M., Salique Forest Station, P.O. Acorn Hoek.
Eulitz, E., Nelsrivier Forest Station, Rosehaugh.
Evans, J. R., Hunters Rise, Viljoenskroon.
Evans, R. B., Woodbush Forest Station, Haenertsburg.
Fischer, S. J., Empangeni Forest Station, Post Bag Empangeni Rail.
Fourie, P. C., Division of Forestry, George.
Fox, M. A., Bellevue Hotel, P.O. Stillbaaistrand.
Fyfe, R. B., Yarrow, Post Bag Howick.
Gardner, R.; nominee of Transvaal Gold Mining Estates Ltd.
Garnett, T. F. F., Division of Forestry, Storms River.
Geekie, J., Benvie, P.O. York.
Genis, J. de G., Division of Forestry, Quoin Point, P.O. Viljoenshof.
Gerber, M. C., Jonkersberg Forest Station, George.
Gildenhuys, F. C. P., Graskop Forest Station, P.O. Graskop.
Glaeser, E. B., Jessievale Forest Station, P.O. Vossmansbeacon.
Godbold, H. R., Border Forest Station, P.O. Harding.

Goodwin, E. A., Division of Forestry, P.O. Box 1, Point, Durban.
Gordon, Col. H., Trennerys, Kentani.
Gordon, J. A., Division of Forestry, Stutterheim.
Graf, Dr. H., P.O. Onderstepoort.
Grahamstown Municipality, Grahamstown.
Gray, Col. W. Park, Cathkin, P.O. Loskop.
Greeff, G. M., Deepwalls Forest Station, Knysna.
Grewcock, A. E., Middelkop Forest Station, P.O. Tzaneen.
Grey, D. M., Division of Forestry, P.O. Box 1, Point, Durban.
Grobler, D. C., Brooklands Plantation, Sabie.
Grobler, W. P., Middlebrook Forest Station, P.O. Harding.
Groenewald, J. A., Division of Forestry, Kokstad.
Guy, G. L., Northern Timber Co., Noorde Wenke, Politsi.
Handley, G. L., Private Bag, Pietermaritzburg.
Harden Heights Wattle Co. Ltd., 9 Timber Street, Pietermaritzburg.
Harlow, W., Sihlamba Farm, Airlie Rail.
Hartig, R. D., Westfalia Estate, Duivelskloof.
Hathorn, J. A., 8 Murray Court, Durban.
Hayter C. S., c/o The Superintendent of the Natal Native Trust Forests, Post Bag, Pietermaritzburg.
Hechter, J. C., Division of Forestry, Port St. Johns.
Hennessy, G. Pope, Division of Forestry, Stutterheim.
Henriksen, Mrs. E. B., Parel Vallei, Somerset West.
Henwood, B. H.; nominee of the Pietermaritzburg Corporation Wattle Dept.
* Hepburn, D. K., P.O. Box 47, Johannesburg.
Herbst, F. A., Laingsnek Forest Station, P.O. Mount Prospect.
Herklots, Dr. G. A. C., The University, Hong Kong.
Hill, Mrs. G., Bracken, Greytown.
Hilligan, C. E., Bathurst Forest Station, Bathurst.
Hochfelden, L. W., Franschhoek Plantation, P.O. La Motte.
Hockly, R. A., Cullendale, Bedford.
Hofmeyr, G. J., Division of Forestry, New Law Courts, Capetown.
Holley Bros., Broadmoor, P.O. Umkabela.
Hubbard, C. S., Division of Forestry, Elgin.
Hulett, B. G., Salt Rock Hotel, Umhlali.
Hunter, D. A., Lovedale.
Hunter, H., Cata Forest Station, P.O. Keiskama Hoek.
Hunter, S. H., P.O. Box 286, Port Elizabeth.
Hunt, Leuchars & Hepburn Ltd., P.O. Box 943, Durban.
Hyde, J. R., Engcobo Plantation, P.O. Engcobo.
Immelman, W. F. E., Division of Forestry, Stutterheim.
Jacobs, E., P.O. Box 1775, Johannesburg.
Jacobs, R. H., P.O. Box 49, Umtata.
Jacobs, W. H., P.O. Box 1775, Johannesburg.
James, Maj. H. T., Ferncliff Estate, Melmoth.
Jeppe, H., Glory Hill Farm, White River.
Jordaan, H. P. L., Stillbay Forest Station, P.O. Stillbaaistrand.
Joubert, G. J., Lichtenburg Plantation, P.O. Lichtenburg.
Joubert, J. A. N., Lothian Forest Station, Private Bag Bushbuckridge.
Joubert, L., Ngomi Forest Station, Ngomi.
Jurriaanse, A., Division of Forestry, Burlington House, Pretoria.
Kapp, F. J., Geelhoutboomberg Plantation, P.O. Blanco.
Kaufman, J. E., Division of Forestry, Kingwilliamstown.
Kay, R. C. V., Division of Forestry, Kingwilliamstown.
Keegan, J. H.; nominee of S.A. General Investment & Trust Co. Ltd.
Keet, J. D., Division of Forestry, Burlington House, Pretoria.
Keet, J. H., Division of Forestry, Bredasdorp.
Kenya Timbers (Pty.) Ltd., P.O. Box 1675, Johannesburg.
Kieser, Dr. A. W., P.O. Box 18, Winburg.
Kimber, G. M., Maritzdaal, Dargle Rail.
Kimberley Municipality, Kimberley. *Nominee* : The Mayor.
King, N. L., Division of Forestry, Burlington House, Pretoria.
Kirkman, J. W., Beeverhowe, P.O. Donnybrook.
Kleynhans, J. P., Govt. Sawmills, Elandshoek.
Klosterschutte, O., Werne Estate, Tzaneen.
* Klugkist, Dr. C. T., P.O. Box 3222, Johannesburg.

Koen, J. H. Hofmeyr, Division of Forestry, Burlington House, Pretoria.
Kotze, J. J., Division of Forestry, New Law Courts, Capetown.
Kotze, P. C., Division of Forestry, Knysna.
Krause, Dr. O., P.O. Box 860, Bloemfontein.
Krogh, P. M. D., Forest Products Institute, Ketjen Street, Pretoria West.
Kropf, G. W. A., Dwessa Forest Station, P.O. Badi, via Willowvale.
Kurland, A.; nominee of Boxes & Shooks (Pty.) Ltd.
Küsel, H. F. C., Honey-Grove, P.O. Harburg, via Dalton.
Kwambonambi Farmers and Timbergrowers Association, Umfolozi.
Lack, C. E., Division of Forestry, Louis Trichardt.
Laughton, F. S., Division of Forestry, Knysna.
Laver, C. S., Bellville Forest Station, Bellville.
Lavin, G. E.; nominee of Kenya Timbers (Pty.) Ltd.
Leith, G., P.O. Box 3590, Johannesburg.
le Roux, H. H., Division of Forestry, Umtata.
Leyland, R. C., P.O. Box 131, Louis Trichardt.
Lindhout, J. van W.; nominee of Middleburg Town Council.
Lion Match Co. Ltd., P.O. Box 918, Durban.
Lister, Miss F. C., Girls High School, Park Street, Pretoria.
† Lister, Mrs. J. Storr, Saint Claire, Kenilworth, Cape.
Llewellyn, T. F., Forest Research Section, Palace of Justice, Pretoria.
Lodemann, L.; nominee of the S.A. Potash Co. (Pty.) Ltd.
Loock, E. E. M., Forest Research Section, Palace of Justice, Pretoria.
Lorentz, D. F. K.; nominee of Vereeniging Estates Ltd.
Lorentz, Dr. H. A., 13 Victoria Avenue, Melrose, Johannesburg.
Loseby, P. J. A., Forest Products Institute, Ketjen Street, Pretoria West.
Louw, A. H., Amanzamnyama Forest Station, P.O. Mount Frere.
Lowry, A. S., Forestry Division, Umtata.
Luckhoff, H. A., Division of Forestry, Pietermaritzburg.
Luckhoff, Dr. J., 43 Alexander Avenue, Oranjezicht, Capetown.
Maasdorp, G. H., Division of Forestry, Jonkershoek, P.O. Stellenbosch.
Macfarlane, D. B.; nominee of Transvaal Gold Mining Estates Ltd.
Mackenzie, G., P.O. Box 3437, Johannesburg.
Mackenzie, G. C., Private Bag Pietermaritzburg.
Mackenzie, T. M., Cramond, Private Bag Pietermaritzburg.
Mackenzie, W. I., Hawkstone, P.O. Howick.
Macmenigall, W. H.; nominee of National Pulp & Paper Co. (S.A.) Ltd.
Maggs, C. O'C., Somerset House, Vermeulen Street, Pretoria.
Malherbe, H. L., Division of Forestry, Burlington House, Pretoria.
Marais, G. A., Division of Forestry, Sabie.
Marais, J. S., Hogsback Forest Station, Alice.
Marks, T., P.O. Hendriksdal.
Marsh, E. K., Forest Research Section, Palace of Justice, Pretoria.
Maynard, A. W.; nominee of Grahamstown Municipality.
McCallum, J., Pigeonhole Farm, Tzaneen.
McCarthy, S. P., Lebanon Forest Station, P.O. Elgin.
McMillan, J. E., Division of Forestry, Butterworth.
Metelerkamp, B. R., Division of Forestry, Sabie.
Methley, W. N., Newstead, Balgowan.
Merriman, C. V., Southern Acres, White River.
Middelburg Town Council, P.O. Box 14, Middelburg, Transvaal.
Miller, O. B., Forest Officer, Mbabane, Swaziland.
Mills, B. Langley, P.O. Box 24, Duivelskloof.
Mills, S. H., P.O. Box 11, Tzaneen.
Mitchell, A. D., Division of Forestry, Knysna.
Mohr, M., Division of Forestry, Burlington House, Pretoria.
Moldenhauer, H., Otterford Plantation, P.O. Loerie.
Monk, W. C., Karatara Forest Station, P.O. Karatara.
Morris, N. H., P.O. Box 1, Mossel River.
Mulke, J. H. F., Knolvlei Forest Station, P.O. Wolseley.
Mullin, P. E., P.O. Dohne.
Mundell, I., P.O. Mount Frere.
Napier, Dr. F. H., P.O. Box 4397, Johannesburg.
Natal, Tanning Extract Co. Ltd., P.O. Box 39, Pietermaritzburg.
National Pulp & Paper Co. (S.A.) Ltd., P.O. Box 1381, Durban.
Naude, J. P. J., Broadholm, P.O. Amsterdam.

Neethling, Prof. E. J., University of Stellenbosch, Stellenbosch.
Nevens, J. J.; nominee of Rand Mining Timber Co. Ltd.
Nevill, C. C. D., P.O. Box 61, Umtata.
Nevill, C. C. D.; nominee of the United Transkeian Territories General Council.
Nicholson, H. B., P.O. Box 899, Johannesburg.
Noffke, F. J., Berlin Forest Station, P.O. Barretts.
Northern Timber Co. Ltd., Noorde Wenke, Politsi.
Oberholzer, J. J., Klein Australie Forest Station, P.O. Ratomba.
O'Connor, A. J., Division of Forestry, Burlington House, Pretoria.
Olivier, G. M., Bergplaats Forest Station, George.
Olivier, W. H. J., Buffalo Nek, Mount Frere.
Payn, G., P.O. Box 26, Harding.
Pearse, D. W., Division of Forestry, Kudu Buildings, Pretoria.
Phillips, Prof. J. F. V., University of the Witwatersrand, Johannesburg.
Pietermaritzburg Corporation Wattles Department, Victoria Road, Pietermaritzburg.
Port Elizabeth City Council, P.O. Box 116, Port Elizabeth.
Pretoria City Council, City Hall, Pretoria. *Nominee*: The Town Clerk.
Pretorius, D. J., Tweefontein Forest Station, Sabie.
Pringle, J. A., P.O. Box 914, Port Elizabeth.
Prinsloo, J. J., Welgevonden Forest Station, P.O. Acorn Hoek.
Prior, D. C., Coetzeestroom Plantation, P.O. Kaapsche Hoop.
Purcell, Yallop & Everett Ltd., P.O. Box 146, Capetown.
Quiding, A. & Son, P.O. Box 6424, Johannesburg.
Quiding, A.; nominee of A. Quiding & Son.
Quiding, D.; nominee of A. Quiding & Son.
Rabbets, C. E., Isidenge Forest Station, Stutterheim.
Rance, H. C., 40 Cambridge Street, East London.
Rand Mining Timber Co. Ltd., P.O. Box 5906, Johannesburg.
Rand Selection Corporation Ltd., P.O. Box 1048, Johannesburg.
Read, H. A., P.O. Box 6403, Johannesburg.
Read, H. A.; nominee of the Transvaal Chamber of Mines.
Reynolds, H., Division of Forestry, Tzaneen.
Riseley, J. W., P.O. Mount Frere.
Robertson, C. C., Bracelet, Winterskloof.
Röscher J. G., P.O. Box 29, Cala.
Rosenhahn, P., Wartburg.
Roux, T. C., Concordia Plantation, Knysna.
Rowan, G. W. M., Division of Forestry, P.O. Studtis.
Rudd, H. P., P.O. Box 616, Kimberley.
Ryan, H. J., c/o Division of Forestry, Umtata.
Saunders, W. S., P.O. Box 4166, Johannesburg.
Scheffler, E. G., Division of Forestry, Barberton.
Schiemer, E. L., P.O. Box 918, Durban.
* Schlimmer, O. K., 192 Regent Street, Observatory, Johannesburg.
Schnetler, S. S., New Agatha Forest Station, Tzaneen.
Schoch, E. L., Nelsrivier Forest Station, P.O. Rosehaugh.
Schonland, R. S., Division of Forestry, Burlington House, Pretoria.
Schurink, W., P.O. Box 55, Lydenburg.
Schwartz, Hyam, P.O. Box 1359, Johannesburg.
Sclanders, G. A., Kelvin Grove, P.O. Loskop.
Scott, M. H., Forest Products Institute, Ketjen Street, Pretoria West.
Searle, C. St. L., Division of Forestry, Nelspruit.
Searles Ltd., Great Brak River.
Seligson & Clare Ltd., P.O. Box 1150, Johannesburg.
Sherry, S. P., Division of Forestry, Tokai, P.O. Retreat.
Sibbett, C. J., P.O. Box 914, Capetown.
Simmons, B. R., 5 Holmfirth Road, Seapoint.
Simmonds, R. N., Dagbreek, Stellenbosch.
Sims, T. E., Evelyn Valley Forest Station, P.O. Gladstone.
Sinclair, J.; nominee of the Transvaal Gold Mining Estates Ltd.
Slabbert, F. W., Belfast Forest Station, Belfast.
Smuts, J. D., Weza Forest Station, Post Bag Harding.
Solomon, V. G. F., P.O. Seymour.
Sonntag, A. E., Division of Forestry, Keiskama Hoek.
South African &General Investment & Trust Co. Ltd., P.O. Box 780, Durban.

South African Native Trust, P.O. Box 384, Pretoria.
South African Potash Co. (Pty.) Ltd., P.O. Box 2033, Durban.
Squier, C. S., Bergplaats Forest Station, George.
Stapleton, C. C., Division of Forestry, Port Elizabeth.
* Starck, G. H., P.O. Box 25, Parow.
Steenkamp, R. A., Entabeni Forest Station, Post Bag Ratomba.
Stellenbosch University, Stellenbosch.
Stephens, H. B., Division of Forestry, Pietermaritzburg.
Stephens, R. P., Division of Forestry, Pietermaritzburg.
Struben, F. E. B., Lynnwood, P.O. Brooklyn.
Summers, A. W.; nominee of Canvacott (Pty.) Ltd.
Surendorff, W., Maresdale, P. Bag Greytown.
Swanepoel, B. H., Nelshoogte Forest Station, P.O. Jambilo.
Symons, B. W., Spitskop, Private Bag Howick.
Talbot, C. R.; nominee of Canvacott (Pty.) Ltd.
Taute, F. G., P.O. Molen River, George.
Taylor, D., 18 Ocean Street, Kensington, Johannesburg.
Taylor, J. B., Lancelevy, St. James, Cape.
Thompson, J. F. Forsyth; nominee of Harden Heights Wattle Co. Ltd.
Thring, T. B.; nominee of Clan Syndicate Ltd.
Tilbrook, E. M., Division of Forestry, Keiskama Hoek.
Transkeian Territories European Civic Association, P.O. Box 3, Engcobo.
Transvaal Chamber of Mines, P.O. Box 1162, Johannesburg.
Transvaal Gold Mining Estates Ltd., P.O. Box 2, Pilgrims Rest.
Transvaal Land Owners Association, P.O. Box 1281, Johannesburg.
Transvaal Lumber Growers (Pty.) Ltd., P.O. Box 2810, Johannesburg.
Turnbull, J. M., Forest Products Institute, Ketjen Street, Pretoria West.
Tustin, J. F., Mvenyani Forest Station, Post Bag Cedarville.
United Transkeian Territories General Council, Umtata.
Urry, A. L. G., Division of Forestry, Graskop.
Uys, J., Spelonken Forest Station, P.O. Zoekmakaar.
van Beeck, N., P.O. Box 7, Hoopstad.
van Beeck, F. Looringh, Rabonie Ranch, Hoopstad.
van der Berg, P. J. A., Fort Donald Plantation, P.O. Kokstad.
* van der Bijl, Dr. H. J., P.O. Box 1091, Johannesburg.
van der Byl, P. A., Division of Forestry, P.O. Eshowe South.
van der Merwe, J. P., Blaauwkrantz Forest Station, P.O. Covie.
van der Spuy, J. T., Lottering Forest Station, P.O. Coldstream.
van der Walt, A. M., Division of Forestry, Kingwilliamstown.
van der Walt, D., Bergplaats Forest Station, George.
van Heyningen, J. W. A., Cathkin Peak, P.O. Loskop.
van Huysteen, N. C., Bergvliet Forest Station, Sabie.
van Lennep, Jonkheer W. F., Gesantschap der Nederlanden, Orangehof, Pretoria.
van Niekerk, A. J., Division of Forestry, Umtata.
van Niekerk, S. W., Tokai Forest Station, P.O. Retreat.
van Rensburg, J. J., Kruisfontein Forest Station, P.O. Knysna.
van Rensburg, M. H., Port Durnford A Plantation, P.O. Felixton.
van Rooyen, H. G., Inyara, P.O. Mooiplaats, East London.
van Rooyen, P. C., Algeria Forest Station, P.O. Citrusdal.
van Wyk, J. D., P.O. Box 2, Riversdale.
van Wyk, J. H., Division of Forestry, Burlington House, Pretoria.
Venter, P. A., Blyde Forest Station, P.O. Blydebos.
Vereeniging Estates Ltd., P.O. Box 49, Vereeniging.
Vermaak, J. G., Spitskop Forest Station, P.O. Sabie.
Vigne, C., 6 Lodge Road, Kimberley.
Visagie, W., Witwater Forest Station, P.O. White River.
Voelcker, J., P.O. Box 1122, Johannesburg.
Voigt, L., Beervlei Forest Station, P.O. Lancewood, George.
von Belkom, G. J. G., Tonti Forest Station, Mount Ayliff.
von Bulow, J.; nominee of Westfalia Estate.
von Dewitz, O., Rand Airport, Germiston.
Voorendyk, J. J., Division of Forestry, Burlington House, Pretoria.
Waterval Estate Ltd., P.O. Hendriksdal. *Nominee*: The Manager.
Watt, W. E., Division of Forestry, Burlington House, Pretoria.
Watts, Dr. J. B. V., Frantzinas Rust, Barberton.

Webb, G. M.; nominee of the Dannemora Iron & Steel Co. Ltd.
Westfalia Estate, P.O. Box 14, Duivelskloof.
Whitcher, J. P., Goedehoop Forest Station, P.O. Ratomba.
Wicht, Dr. C. L., Division of Forestry, Jonkershoek, P.O. Stellenbosch.
Willan, R. G. M., Forestry Division, P.O. Dedza, Nyassaland.
Wille, D. L., Maryvale, P.O. Lothair.
Wimbush, S. H., P.O. Box 337, Nairobi.
Winckworth, A., Groenkloof Nursery, P.O. Pretoria Station.
Wood, E. B., Division of Forestry, George.
Woodcock, A., Elgin Forest Station, P.O. Elgin.
Wroughton, F. H., Civil Service Club, Church Square, Capetown.
Zahn, G. A., Division of Forestry, Umtata.

Lede wat verkies om hulle adresse in Afrikaans te laat verskyn word vriendelik versoek om hulle wense aan die Ere-Sekretaris mee te deel, sodat toekomstige lyste, wat hierdie saak betref, verbeter kan word.

EDITORIAL COMMITTEE.

J. M. TURNBULL, DIP.FOR.—*Chairman.*
I. J. CRAIB, M.F., PH.D.
A. JURRIAANSE, B.Sc. (AGRIC.), B.Sc. (FY.)
PROFESSOR E. J. NEETHLING, B.A., M.F.
A. J. O'CONNOR, DIP.FOR.
PROFESSOR JOHN PHILLIPS, D.Sc., F.R.S.E., F.L.S.
E. K. MARSH, B.A.—(*Secretary*)

Contributions on any aspect of forestry or allied subjects will be considered by the Editorial Committee, and should be addressed to the Editor, The Journal of the South African Forestry Association, P.O. Box 727, Pretoria. Articles in excess of 1,000 words should be accompanied by uncopyrighted summaries, not exceeding five per cent. of length of originals. Twelve reprints of each article will be furnished to its author, free. Reprints beyond that number may be obtained, if ordered before the end of the month preceding that of issue, at the following rates per unit of four text pages :—

100	*copies*	£0 16 6
250	,,	£1 5 6
500	,,	£2 0 6
1,000	,,	£3 10 6

Incomplete units will be charged as for complete units. Printed covers ordered at same time as the text will be provided at 21/6 per 100, and 2/- for every 50 in excess thereof. Illustrations extra by arrangement.

Articles will be published in the language in which they are submitted. Summaries may be submitted in either or both official languages.

The Association does not hold itself responsible for statements or views expressed by authors.

Readers are urged to consider the Association's advertisers as occasion may arise.

REDAKSIE-KOMITEE.

J. M. TURNBULL, DIP.FOR.—*Voorsitter.*
I. J. CRAIB, M.F., PH.D.
A. JURRIAANSE, B.Sc. (LB.), B.Sc. (BSB.)
PROFESSOR E. J. NEETHLING, B.A., M.F.
A. S. O'CONNOR, DIP.FOR.
PROFESSOR JOHN PHILLIPS, D.Sc., F.R.S.E., F.L.S.
E. K. MARSH, B.A.—(*Sekretaris*)

Artikels oor alle aspekte van bosbou sal deur die Redaksie-Komitee in oorweging geneem word, en moet aan die Redakteur, „The Journal of the South African Forestry Association," Posbus 727, Pretoria, gerig word. Artikels van meer as 1,000 woorde moet van 'n opsomming van nie meer as vyf persent van die lengte van die artikel self, waarvan kopiereg nie voorbehou is nie, vergesel word. Twaalf herdrukke van elke artikel sal kosteloos aan die skrywer daarvan verskaf word. Mits hulle bestel word voor die einde van die maand voorafgaande die van uitgawe, kan herdrukke bo hierdie hoeveelheid teen die volgende pryse vir eenhede van vier teksblaaie verkry word:—

100 *kopies*	£0	16 6
250 „	£1	5 6
500 „	£2	0 6
1,000 „	£3	10 6

Onvolledige eenhede sal teen dieselfde prys as volledige eenhede gereken word. Gedrukte omslae, bestel gelyktydig met die herdrukke, sal voorsien word teen 21/6 per 100, en 2/- per elke 50 bo die eerste 100. Illustrasies ekstra.

Kontribusies sal gepubliseer word in die taal waarin hulle ingestuur word. Opsommings mag in enige of beide amptelike tale ingedien word.

Die Vereniging neem geen verantwoordelikheid vir bewerings of opinies van skrywers nie.

Lesers word versoek om die Vereniging se adverteerders waar ge-

CONTENTS—INHOUD

The Association does not hold itself responsible for statements or views expressed by authors. With the exception of authors' summaries copyright of all articles is reserved.

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of menings wat deur skrywers uitgespreek mag word nie. Met uitsondering van skrywers se opsommings, word kopiereg van alle artikels voorbehou.

PAGE

EDITORIAL NOTES AND COMMENTS—VAN DIE REDAKSIE 1

SOUTH AFRICAN TIMBER INDUSTRIES AND THE WAR.

DIE UNIE SE HOUTINVOER.

STATE SALES OF BLACK STINKWOOD TIMBER.

A SOUTH AFRICAN FORESTER HONOURED.

IMPERIAL FORESTRY BUREAU.

DISTINCTION FOR THE JOURNAL.

ONS NUWE OMSLAG.

SERIALIZATION OF GOVERNMENT PUBLICATIONS.

THE LATE PROFESSOR P. A. VAN DER BYL.

DEATH OF PROFESSOR TROUP.

THE KNYSNA FORESTS AND THE WOODCUTTER PROBLEM, *by N. L. King, Dip.For* 7

A KEY TO THE SPECIES OF *Eucalyptus* GROWN IN SOUTH AFRICA, *by E. K. Marsh, B.A.* 16

FOREST INFLUENCES RESEARCH TECHNIQUE AT JONKERSHOEK, *by C. L. Wicht, B.Sc., B.A., Dr.Ing.* 65

HOUTPRESERVERING, *deur J. H. van Wyk, M.Sc., M.F. en P. J. A. Loseby, B.A., B.Sc.* 81

ELECTRIC MOISTURE-IN-TIMBER METERS, *by M. H. Scott, B.Sc.* 100

AN IMPROVISED POLE-TESTING MACHINE, *by John M. Turnbull, Dip.For. and P.M.D. Krogh* 103

THE BEGINNING OF FORESTRY EDUCATION IN SOUTH AFRICA ... 108

A METHOD OF STACKING POLES IN RESTRICTED YARDS, *by P. J. A. Loseby, B.A., B.Sc.* 110

CROSS-SECTION DIMENSIONAL ADJUSTMENT OF SUBSTITUTE TIMBERS, *by John M. Turnbull, Dip.For.* 111

CORRESPONDENCE—KORRESPONDENSIE 113

PLANT SUCCESSION ON THE TRANSKEIAN COAST.

GROWING *Eucalyptus Saligna.*

DESTRUCTION OF NATIVE FORESTS IN NORTHERN ZULULAND.

REVIEWS—RESENSIES 117

ELEMENTARY FOREST MENSURATION.

TEXTBOOK OF DENDROLOGY.

LUMBER: ITS MANUFACTURE AND DISTRIBUTION.

PLANT COMPETITION IN FOREST STANDS.

ANATOMIE DE LA FEUILLE CHEZ LES PINS MARITIMES and CLASSIFICATION DES PINS MARITIME.

THINNING, PRUNING AND MANAGEMENT STUDIES OF THE MAIN EXOTIC CONIFERS GROWN IN SOUTH AFRICA.

TIMBER DRYING AND THE BEHAVIOUR OF SEASONED TIMBER IN USE.

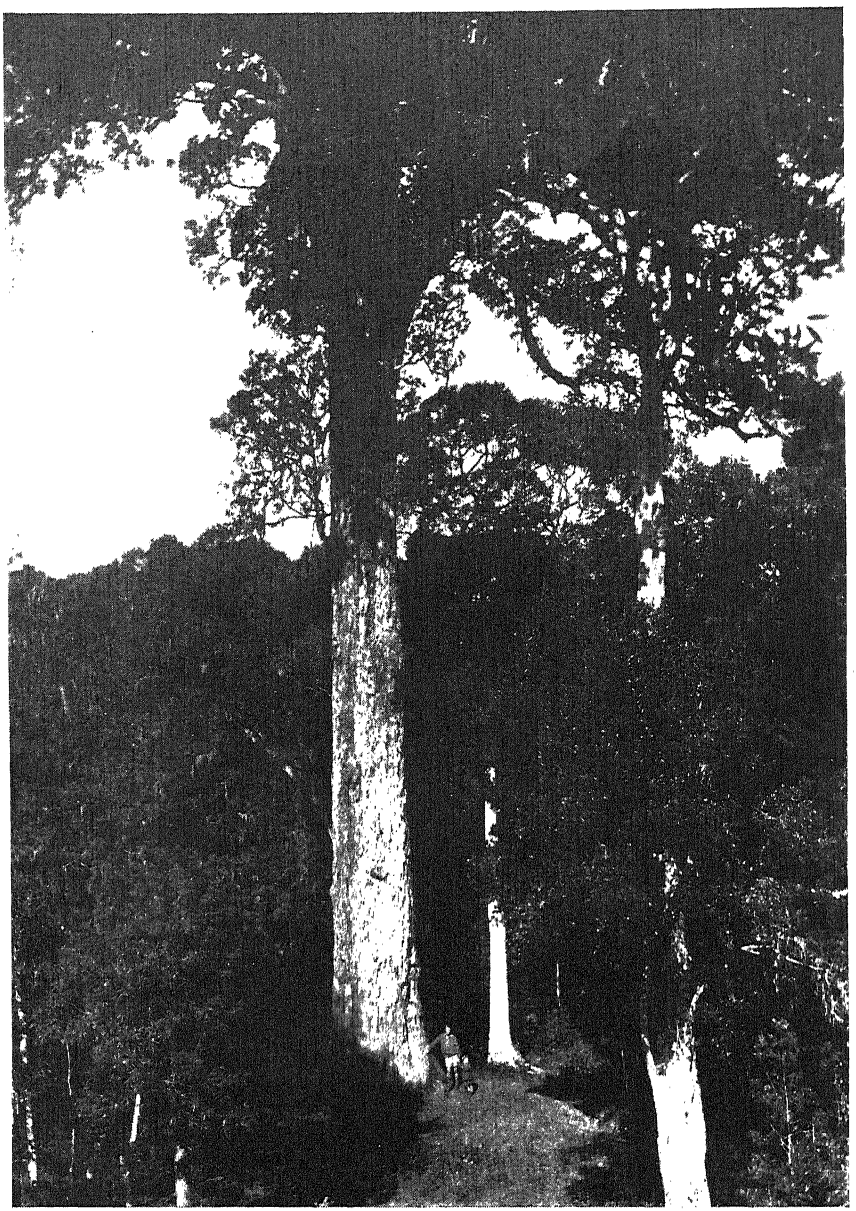
THE TIMBER AND SAWMILLING INDUSTRIES (of South Africa).

FORESTRY ABSTRACTS.

PUBLICATIONS RECEIVED—UITGAWES ONTVANG 126

Attention is drawn to the announcement on our last page regarding the Association's publicity stamp.

Aandag word bepaal by die aankondiging in verband met die Vereniging se reklameseël wat op die laaste bladsy verskyn.



THE "BIG TREE" (*Podocarpus Falcatus*) at Deepwalls, Knysna. Height 137 ft. Length of bole 70 ft. B.H. diameter 6ft. 0in.

Photo by Mr. Fyfe, Knysna.

THE JOURNAL OF THE
SOUTH AFRICAN FORESTRY ASSOCIATION
No. 3. OCTOBER, 1939.

DIE TYDSKRIF VAN DIE
SUID-AFRIKAANSE BOSBOUVERENIGING
No. 3. OKTOBER, 1939.

EDITORIAL NOTES AND COMMENTS.

VAN DIE REDAKSIE.

South African Timber Industries and the War.

The outbreak of war in Europe once more serves to demonstrate the dependence of South Africa on foreign supplies of timber and wood products. Interruption in ocean transport and the increasing cost of imported articles have stimulated local manufacture in several directions and increased the normal demand for home-grown wood and its products. It is not now the academics of a world shortage of timber that needs to be debated. Fundamental and more practical consideration of the adequacy of domestic resources has now assumed importance and serves to demonstrate the wisdom underlying the Government's afforestation policy. Problems of unemployment, the aftermath of the world war, gave impetus to extension of afforestation. Plantations established to solve this problem will, in the present crisis, contribute to the rescue of the country in its need. Some of these plantations are already capable of yielding regular supplies of appreciable volume of sawable wood in perpetuity.

Interruption in importation has caused an acute shortage of timber required for many purposes and in its concern over the adjustment of this problem the country has looked, in the first instance, to the plantations to augment the available supplies. The indigenous forests are, as a result of over-exploitation, no longer a factor of importance in this connection. In order to relieve the situation to the fullest extent possible the Forest Department has decided to place on the market all the timber that can be removed without injury to the plantations and without prejudicing their continuity of production. This addtional volume of wood is considerable but will not yet meet all requirements. Importation will still be necessary.

The Government is at the same time extending the existing State sawmills, where this is practicable, and erecting new sawmills and timber factories. The more immediate problem is therefore not that of supplies of sawable wood, but one of machinery to manufacture what can be made available. Circumstances have now created an opportunity for developing the sawmilling industry. Speculation in timber resources will be guarded against, and those who enter the timber industry will be required, under suitable guarantee, to develop their business on a permanent basis.

The mining industry is assured of meeting its requirements in wood for props. The wattle bark industry is capable of expansion, and the trade lost to it by collapse of the Union-German Payments Agreement is likely to be made good by increased demand from other countries. The match factories can also obtain greater local supplies of poplar wood than formerly, and their policy of assisting financially the growing of poplars is thereby fully justified. Pulpwood is available in quantity in several localities and the pulpmill and paper factory on the Rand is now in full production. Generally the country will look with gratitude and expectation to those sawmill owners who during times of depression and times of subsidising of exports by foreign timber producing countries, have consistently pioneered the timber industry against opposition and against the proverbial prejudice which the average South African has with respect to the products of his own land.

DIE UNIE SE HOUTINVOER.

Die Unie is vir sy houtbenodighede tot dusverre nog hoofsaaklik afhanklik van die buiteland. Dit geld nie alleen vir sagtehout nie, maar ook vir sekere hardehoutsoorte soos byvoorbeeld Teak en Eikehout, waaruit die groot gros van die fabriek-vervaardigde meubels in hierdie land gemaak word. Die aanvrag vir hout is besonder elasties en word sterk beinvloed deur ekonomiese toestande. Gedurende 1910-14 was die gemiddelde jaarlikse invoer ongeveer 16 miljoen kub.vt., maar gedurende die oorlogjare 1915-18 het dit gedaal tot 'n gemiddelde van slegs 6 miljoen. Dit was in werklikheid 'n tyd van houthongersnood want deur gebrek aan skeepsruimte was hout van oorsee moeilik verkrybaar. Die oorlogsjare is in 1921 gevolg deur 'n kort periode van hoë konjunktuur toe ons invoer gestyg het tot 13.1 miljoen kub.vt., en toe gevolg is deur wisselvallige skommelinge wat uiterste peile van 6.7 en 31.7 miljoen kub.vt. geraak het om uiteindelik 22.8 miljoen in die laaste voltooide jaar te bereik. Staan ons houtinvoer nou op die drempel van 'n totnogtoe ongehoorde daling?

STATE SALES OF BLACK STINKWOOD TIMBER.

The sale by public auction of Black Stinkwood (*Ocotea bullata*) from the Crown forests in the districts of George, Knysna, and Humansdorp, has already demonstrated very clearly the pecuniary advantage of this method as opposed to selling the wood standing at tariff rates varying from 6d. to 2s. per cubic foot for round logs, or 1s. 6d. to 3s. for squared timber. As stated by Mr. King in his article in this issue on the Knysna forests and the woodcutter problem, exploitation of these forests has been undertaken departmentally as from 1st April, 1939. Logs are delivered at depots where they are graded into prime, average, and merchantable qualities. Those of prime

quality are sold by public auction, and poorer grades will be disposed of by tender. At the auction sales concluded early in September, 3,845 cu. ft. of Stinkwood timber were offered, all of which was disposed of at an average price of 11s. 2d. per cu. ft. The highest price paid was 27s. per cu. ft. for a log extracted from Blaauwkrantz Forest. Departmental exploitation of Stinkwood has also been undertaken in the Transkei, where 3,995 cu. ft. were sold by formal tender at an average price of 5s. 9d.

A South African Forester Honoured.

We have to congratulate Mr. C. E. Legat, for many years Chief Conservator of Forests for the Union, whose election as a Vice-President of the Association we are pleased to announce, on the award of the C.B.E. which was conferred on him in the King's birthday honours list for services rendered to the Empire in his late capacity of Editor-Secretary of the Empire Forestry Association.

Imperial Forestry Bureau.

We have been informed that Mr. J. D. Keet, Director of Forestry, and Chairman of our Association, has been appointed as the Union's official correspondent to the Imperial Forestry Bureau. A notice of the Bureau's first printed publication, *Forestry Abstracts,* appears in our "Review" pages.

Distinction for the Journal.

Members who visited the exhibition of printed books of all ages and countries held last August at the Pretoria Technical College under the auspices of the Bureau of Adult and Visual Education of that Institution will have experienced pleasurable surprise at seeing amongst the exhibits a copy of our second issue. It was displayed as a demonstration of what can be achieved locally in the lay-out and printing of periodicals.

Ons Nuwe Omslag.

Volgens 'n mosie wat deur die jongste algemene vergadering van die Vereniging aangeneem is, is die omslag van hierdie uitgawe van ons tydskrif verander met die doel om die uitbreiding van sy titel te verwesenlik deur om dit, ooreenkomstig afdeling vii (2) van die konstitusie, in albei amptelike tale te laat verskyn. Dit is bedoel om die posisie van die twee tale bo en onder die wapen afwisselend in agtereenvolgende uitgawes om te ruil. In hierdie verband is die hoop uitgespreek dat lede deur hierdie nuwe vorm aangespoor sal word om meer artikels in Afrikaans in te dien.

Serialization of Government Publications.

The practice of inaugurating new series of bulletins, pamphlets, etc., on the reorganisation of government departments, both in South Africa and abroad; of maintaining major and minor series, such as "Department of Agriculture and Forestry's bulletin No. 164, Forestry Series 5"; and differentiation even in respect of format, is to be deplored. The practice is capricious. It is the bane of cataloguers, confuses

citation, and complicates requisitioning. There seems to be nothing to prevent the keeping of a central register for publications by each government. Under such a practice, a government office on securing authority to print any bulletin, pamphlet, report, or circular, would furnish particulars to the Government Printer, or whatever officer might be entrusted with the keeping of the register, who would then allot to the publication concerned the next serial available. Each publication issued under this system would bear one clearly marked serial only. Should a service register be impracticable, departmental ones at least might be given a trial.

The Late Professor P. A. van der Byl.

ON the 25th July, 1939, Agriculture and Forestry suffered an irreparable loss by the sudden demise at Stellenbosch, of Professor Dr. Paul Andries van der Byl.

Dr. van der Byl was the son of a well known old Cape family which traces its ancestry to one Gerrit van der Byl who settled at the Cape in 1664. He was born at Nattevlei, Stellenbosch, on the 23rd May, 1888, and received his early education there from a governess and later attended the boys' high schools of Wynberg and Stellenbosch. Following his matriculation he entered the Victoria College, where, in 1909, he graduated B.A. Hons. in Botany, after which, for a short time, he was a Science Master at Bethlehem, O.F.S.

In 1911 he entered the service of the Union Department of Agriculture and while stationed at Pretoria and Durban devoted his attention to mycological and phytopathological researches. During this period he obtained, through private study, both the M.A. and the D.Sc. degrees of the University of the Cape of Good Hope.

In 1921 the University of Stellenbosch created a chair in Phytopathology and Mycology, the first, and to-day still the only one of its kind, in South Africa, and van der Byl was honoured in being its first occupant.

While at Stellenbosch he became Dean of the Faculty of Agriculture, and in 1928 Principal of the Stellenbosch Elsenburg College of Agriculture of the University of Stellenbosch, a position he held with great dignity and success until his death.

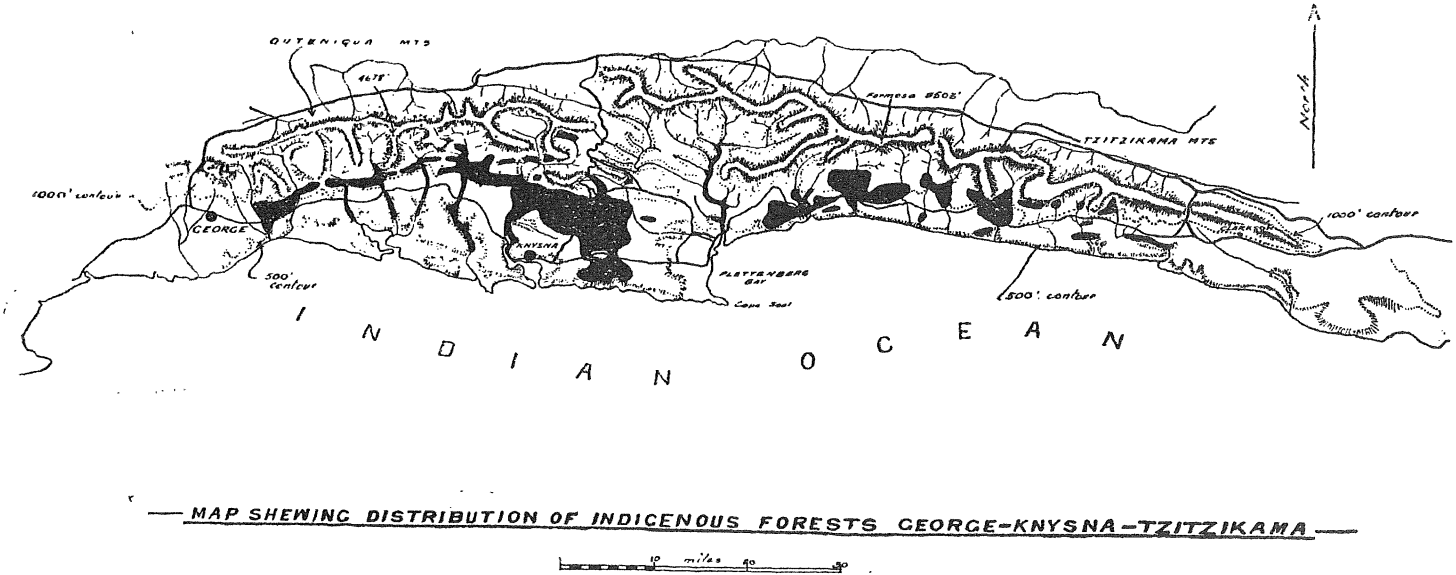
His interests in Pathological problems in Forestry started early, as is evidenced by his first scientific publication dealing with a mottled disease of the black wattle. He published many others on the decays of our indigenous forest trees, which, with his related collections, gained for him international recognition. His valuable Herbarium has been left to his Alma Mater with sufficient funds to allow of its being properly preserved.

His interest in forestry was not confined to its pathological aspects. He was amongst the first and strongest movers for the establishment of a course of higher professional forestry training in South Africa. In this he worked most persistently and his wish became a reality when in 1932 the first chair of forestry was established at Stellenbosch University. Its success has in no small measure been due to his sympathetic and loyal support. Forestry in South Africa has had no stronger and truer friend and is all the poorer as a result of the early death of one of its most staunch supporters.

E.J.N. and L.V.

Death of Professor Troup.

We have received at the moment of going to Press news of the death at Oxford on the 1st October, at the age of 64, of Dr. R. S. Troup, Professor of Forestry at Oxford University. Professor Troup received his school and university education at Aberdeen, and after training at Cooper's Hill, proceeded in 1897 to Burma, where he assumed the post of Assistant Conservator of Forests. After filling a succession of increasingly responsible posts in India, including the Assistant Inspector-Generalship, he was appointed in 1920 to the Chair of Forestry at Oxford, with the duties pertaining to which during the period 1924 to 1935 he combined those of Directorship of the Imperial Forestry Institute. In these positions he achieved extraordinary success in the co-ordination of forestry endeavour in the British Commonwealth. His contributions to forest literature, particularly his *Silviculture of Indian Trees, Silvicultural Systems,* and his intensely interesting monograph on *Pinus longifolia,* are high achievements in the recording and interpretation of personal observation. Professor Troup died in harness. He was to have retired in July, next year. His death will be deeply regretted by foresters in South Africa, not only out of respect for achievements which earned for him an impressive array of distinctions, but also because of remembrance of a personality that charmed all who met him during his visit to the Union in 1935 as a delegate at the Empire Forestry Conference.



THE KNYSNA FORESTS AND THE WOODCUTTER PROBLEM.
Map of Districts showing forests in black.

THE KNYSNA FORESTS AND THE WOODCUTTER PROBLEM.

By N. L. KING.

(Chief Management Officer, Division of Forestry)

A PROCLAMATION issued on the 15th March, 1939, announced the repeal of the special regulations for the control and management of Crown Forests in the Districts of George, Knysna and Humansdorp. This Proclamation coupled with the Woodcutters' Annuities Act of 1939, brings to a close the long drawn out struggle between forest service and woodcutters; a struggle on the part of the former to prevent the complete ruination of these once magnificant forests. Few, if any, outside the service appreciate fully how the woodcutter problem affected the management of the forests. A brief sketch of the problem and the reasons for the enactments referred to above may therefore be of interest.

The forests under discussion commence a few miles West of George and extend eastwards for a distance of about 120 miles and peter out near Clarkson, where the Tzitzikama mountains disappear into the sea. This strip is only from about 4 to 17 miles wide and is hemmed in by the lofty Outeniqua and Tzitzikama mountains on one side and on the other by the sea. The forests do not form a continuous belt but occur in patches along the foothills and spurs of the mountains and in the deep river gorges which cut across the plateau between the mountains and the sea. Here and there forests occur on the plateau itself and in a few places descend to sea level. Out of the total area of 103,000 acres owned by the state, 12,000 acres are situated in the George district, 53,000 acres in Knysna and 38,000 in Humansdorp district. In addition to State forests, about 50,000 acres of forested ground are privately owned.

There seems to be little doubt that in their virgin state the forests consisted of an upper storey of giant Outeniqua yellowwoods (*Podocarpus falcatus*) with an understorey of upright yellowwood (*Pod. latifolius*) and many broad-leaved species such as ironwood (*Olea laurifolia*), assegai (*Curtisia faginea*), white pear (*Apodytes dimidiata*), stinkwood (*Ocotea bullata*), *red els* (*Cunonia capensis*), white els (*Platylophus trifoliatus*), kershout (*Pterocelastrus tricuspidatus*), vlier (*Lachnopylis floribunda*), beukenhout (*Rapanea melanophleos*), hard pear (*Olinia cymosa*), and kamassi (*Gonioma kamassi*). Keurboom (*Virgilia capensis*) is widespread but generally occurs along the forest edge and acts as a pioneer to other species.

From the meagre records available it would appear that, exclusive of shipwrecked mariners, the first Europeans to come into contact with the forests were Dutch colonists, who, in their movement eastwards, settled on or near the site of the present town of George in 1711. It is not known whether these people opened up a timber trade with

Cape Town but it is probable they did so and thus brought the forests to the notice of the authorities. The first definite evidence of exploitation is to be found in 1772 when a "timber post" was established alongside the George forests to supply the settlement at Cape Town with timber. Six years later a similar post was established at Plettenberg Bay, presumably with the object of reducing costs by using the sea instead of overland transport. During the first, and for some time after the final cession of the Cape to Britain in 1806, the post was run by the Admiralty until it was finally closed down about 1820 as a result of discontinuance of the use of Knysna timbers for naval purposes. What happened to the men employed at these timber posts is not known but it may reasonably be assumed that those engaged on felling and transporting timber remained there and became woodcutters.

Very heavy felling must have taken place in Harkerville forest which, in 1811, was stated to be "nearly exhausted from its facility of access and contiguity to the bay." This statement, it would appear, referred to sound trees only, for a Naval Officer named Jones, who made a very thorough examination of the forests, merely reported a scarcity of "good timber." The forests near George also appear to have suffered heavily as the Resident in 1805 was instructed to look to their preservation. Round about Knysna the forests were rather inaccessible and as a result their exploitation did not begin until a year or so after 1817 when the Knysna river was found to be navigable by ships of shallow draught.

Little is known about the working of the forests from 1820 to 1847. Mr. Rex has left it on record that during the period 1821-39, 17,966 tons of timber were shipped from Knysna and that the total amount cut annually in the forests averaged about 66,000 cu. ft., a good deal of which found its way to inland markets. By 1847 the Government had become perturbed about the destruction that was taking place and took the heroic decision to close the forests against further cutting but naively added that, in order not to inconvenience the timber trade, the forests would be cut up into lots and sold. A number of these lots were actually disposed of before better counsels prevailed. A Conservator of Forests and a few rangers were appointed to prevent further depredations.

The closure of the forests gave rise to a storm of protest and as a result they were re-opened in 1856. An additional Conservator was then considered necessary and Captain Harison was appointed to the post with head-quarters in the Tzitzikama. It is mainly due to his indefatigable efforts that all of the Crown forests were not disposed of and that those which remained unsold were not destroyed.

Up to the time of Harison's appointment, woodcutters had almost complete liberty of action and could cut what they liked and where they liked. They naturally resented any curtailment of these liberties. Harison, writing in 1874, said "the Crown forests have for so many years been regarded as the exclusive property of the traders and woodcutters that anything that has a tendency to check pillage, reckless felling and waste is deemed a tyranny and overbearance on my part." This check on unrestricted working may be said to be the beginning of the woodcutter problem. What Government failed to realise at the time was that a sustained yield is the basic principle of sound forest management and that overcutting would not only destroy the forests

but bring about the ultimate collapse of the woodworking industries dependent upon the forests for their raw materials.

As indicative of the official attitude, Harison was instructed to "treat the woodcutters with as much consideration as you can. If they want more time (or more wood) give it." The woodcutter question eventually became a political matter and the welfare of the forests was subordinated to the ballot box against which representations by forest officials were of little avail.

As far back as 1856 a considerable population had grown up in the vicinity of the forests and was almost, if not entirely, dependent on woodcutting for a means of livelihood. There was little else for these people to do as distances from markets, bad roads and poverty stricken soil militated against agricultural or stock farming. To make matters worse, Government embarked, in 1879, on an ill advised scheme to settle immigrants on waste lands near the forests. These immigrant locations were a failure and the settlers had perforce to turn to the forests, to earn a livelihood. Among the settlers were a number of Italians who were imported from Turin to start a silk industry near Knysna. The fact that mulberry leaves were needed to feed the silk worms was overlooked and consequently the industry failed to materialise. To relieve their distress these settlers were employed on the construction of a road from Knysna to Gouna and in course of time they drifted into the ranks of the woodcutters.

Government had by this time begun to realise the necessity of placing the management of the forests on a sound basis. With this object in view the services of Count de Vasselot de Regné, an eminent French forest officer, were obtained under contract. The Count after a thorough examination of the forests was responsible for the issue of amended regulations in 1883. Under these regulations the method of working the forests in sections, which Harison started in the Tzitzikama, was made general and woodcutters were charged for the full volumes of utilisable timber in trees which they felled. The latter was to check the appalling amount of waste which took place under the old method of sale, whereby saw logs were cut into 20 ft. lengths and the pieces left over allowed to rot in the forests.

Two years later the Count issued detailed instructions for the working of the forests in accordance with the 1883 regulations. In these instructions we find the first attempt at bringing about a sustained yield. Briefly the scheme was to divide the forests into blocks of from 400 to 1,000 morgen and each block into forty sections containing approximately the same amount of timber. Every year one section in each block was to be marked for felling and then closed to further cutting until the next felling cycle came round forty years later. About one-third to one-half of the mature and overmature trees were to be marked for felling and the remainder left for shelter and seeding. A prescription of considerable importance laid down that decayed trees and undesirable species should be removed to make way for regrowth of the better kinds. By these means it was hoped that in two or three felling cycles all mature, overmature and decayed trees and undesirable species would be removed and their places taken by a healthy and vigorous crop of species which were in strong demand.

The broad principles were sound enough but several factors militated against the success of the scheme. Insufficient data existed in respect

of the rates of growth of the several species. It was subsequently found that sections marked during the second felling cycle yielded only about one-third to one-half of the amount obtained during the first marking. The result was that in order to satisfy the needs of the woodcutters more than one section had to be marked and this upset the original plan. Another factor was that woodcutters remained the sole arbiters of the trees to be felled. They merely picked out from the marked trees those they desired and left the remainder. As no facilities existed for dealing with the latter by Departmental means, they were perforce left to clutter up the forests and interfered with the development of regrowth.

Complaints from woodcutters were many and varied and several Commissions were appointed to enquire into their grievances, without accomplishing anything of value as far as forest conservation was concerned. In fact the position grew steadily worse as the sons of woodcutters reached manhood and took to woodcutting on their own account. It became quite obvious that, unless a halt was called to the increasing numbers of woodcutters, the forests were doomed to destruction in a comparatively short space of time. The first definite step in this direction was taken in 1913 when the Forest Act of 1888 was amended by Parliament. Under the amended Act, the Government was empowered to draw up a list, to which no more names would be added, of those whose main occupation consisted of woodcutting and were therefore entitled to be regarded as *bona fide* woodcutters. The original list was drawn up by Boards appointed for the purpose and contained the names of 1,267 persons. By virtue of registration these people became a privileged class and acquired a complete monopoly over the purchase of wood from the forests. Although the scheme had drawbacks, it brought the solution of the woodcutter problem within measurable distance.

By 1923-24 the number of woodcutters had been reduced to 628, and the annual cut to 313,000 cu. ft. or roughly 500 cu. ft. per man. As a result of concessions the cut rose to 585,000 cu. ft. in 1925-26 and averaged 535,000 cu. ft. or 972 cu. ft. per man for the seven years from 1925-26 to 1931-32.

This policy of appeasement not only disheartened forest officials but had results unexpected by those not closely in touch with the timber trade. The flooding of a market capable of absorbing only a limited amount of timber resulted in a sharp drop in prices and the woodcutters after much additional labour found themselves little better off financially.

Forest officials became seriously perturbed at the undoing of years and years of patient work. It was generally known that the forests were rapidly being worked to exhaustion but in order to take stock of the actual position an exhaustive valuation survey of the Tzitzikama and Knysna forests was undertaken in 1928 and completed in 1930. The survey was not extended to the George forests as they had long ceased to be of any importance as far as timber supplies were concerned. The investigation showed clearly that the annual cut should immediately be reduced to 183,000 cu. ft. a year or roughly 340 cu. ft. per woodcutter. It was suggested that the position could be met by buying out the woodcutters and working the forests Departmentally. The time, however, was not opportune as the cost would have been

prohibitive, on account of the large number of names then on the register. The matter was revived in 1937 and as already stated has been brought to a successful conclusion. The first step involved getting a measure called the Woodcutters' Annuities Act through Parliament. Under this Act woodcutters not qualified for old age pensions or the benefits of the scheme for the unfit were granted annuities of £25 each. The amount was decided upon after very careful investigations had been made into their average earnings at woodcutting. As far as possible the annuitants will be employed on felling and log making and others will find employment in slipping logs from the forests to depots. In these ways the men concerned will be able to supplement their annuities very considerably and will be in a much better financial position than hitherto. The final stage was the deregistration of woodcutters by Proclamation No. 58 of 1939 which repealed the special regulations referred to in the opening paragraph. Under Departmental working the timber extracted from the forests will be sold by auction or tender and is expected to realise sufficient to cover not only the tariff rates at which it was hitherto sold but also the cost of exploitation and the value of the annuities.

The quantity of timber yielded by the forests will never be known but a rough idea will be obtained from the following statement:—

1772 to 1841	—70 years at 50,000 cu. ft. ...	3,500,000 cu. ft.
1842 to 1881	—40 years at 100,000 cu. ft. ...	4,000,000 cu. ft.
1882 to 1889	— 8 years at 142,000 cu. ft. ...	1,136,000 cu. ft.
1890 to 1937/38	—50 years at (actual returns) ...	16,443,000 cu. ft.
1772 to 1937/38	—168 years	25,079,000 cu. ft.

The heavy exploitation extending over a period of more than 160 years has reduced many magnificent forests to a state of almost complete exhaustion. Originally the State forests may have been classified as follows:—

Timber producing forests	92,300 acres
Scrub forests	10,700 ,,
Total	103,000 ,,

A recent survey of their condition revealed the following position:—

Still exploitable	17,300 acres
Over exploited	51,800 ,,
Reduced to Kreupelbos	23,200 ,,
Scrub	10,700 ,,
	103,000 ,,

The Kreupelbos will take centuries to recover unless the process can be hastened by artificial means.

Let us now consider past exploitation in more detail. Although the forests in the George-Knysna-Tzitzikama area contain a fairly large number of species only certain kinds have been in much demand. From the days of the establishment of timber posts at George and Plettenberg Bay, stinkwood has been rightly regarded as the most valuable wood and consequently has been the most sought after. It

was used extensively for wagon and cart building, furniture, bridges, and yokes, and later was even specified for railway sleepers. In 1818 the Government instructed its officials that "stinkwood timber in the forests adjacent to the Knysna, should be secured solely for the Government purposes and on no account be permitted to be cut for the use of any individuals." In 1880 the Conservator reported that "stinkwood is five or six times more sought after than yellowwood and almost twice as much as the mixed woods which constitute loads of wagon wood." Vast quantities were undoubtedly cut and removed prior to 1876 but figures are not available. The quantities removed at different periods between 1876 and 1937/38 are shown in table 1.

Table 1

STINKWOOD REMOVED AT VARIOUS PERIODS BETWEEN 1876 AND 1938.

Period	Quantity cu. ft.	Average Annual Quantity—cu. ft.
1876-1880	163,000	32,600
1889-1905	753,500	44,328
1913-1920	238,827	34,118
1931-1938	102,158	14,594

Although the figures from 1876 to 1937/38 are incomplete it may reasonably be assumed that the total quantity cut during this period was at least 1,250,000 cu. ft. It would probably not be very wide off the mark to say that prior to 1876 three million cu. ft. were removed, making a total of 4¼ million cu. ft. from 1772. The table given above is significant in that it shows the sharp decline in the yield of this valuable species during recent years. As we shall see later the yield will have to be still further reduced to eke out the available supplies.

Next in demand were white pear for felloes, assegai for spokes and middling sized yellowwood for naves and carpentry purposes. Ironwood was hardly in demand until after 1890. Previous to this it remained "almost untouched in the forests of Knysna." Hutchins when Conservator of Forests at Knysna, recommended that the trees should be ringbarked otherwise the forests would pass over to "ironwood wastes" instead of "stinkwood reserves." A certain amount of ringbarking was actually carried out but the operation was soon discontinued. Ironwood subsequently came into use for wagon parts and has been in steady demand since then.

As already noted above only middle sized yellowwoods were saleable up to about 1880. To encourage the sale of large trees, woodcutters were allowed 25 cu. ft. free on each tree worked. For some years following the severe depression in the Cape about 1879 the timber trade was completely in the doldrums. To relieve the plight of the woodcutters and to assist the railways, Government decided to use creosoted yellowwood sleepers. Contracts were entered into with private persons to supply 600,000 sleepers (about 1¼ million cu. ft.)

over a period of five years. These contracts gave rise to a good deal of trouble and were cancelled after a year or two. Government took over the plant and transferred it to Knysna, where creosoting was commenced in 1884. Since that date most of the yellowwood, which averaged about 50 per cent. of the total yield from the forests, has been converted into sleepers.

About 1895 kamassi was found to be suitable for certain purposes in the textile industry. Since then a good deal has been exported annually. The total amount disposed of from Crown forests is not known but during the period 1921/22 to 1937/38 some 433,500 cu. ft. were sold or roughly 25,500 cu. ft. a year.

The pernicious practice of culling only certain species has resulted in lowering the general height of the forests and has considerably altered their composition. The latter is well brought out by the table given below. In 1900 the number of mature trees per acre was determined by marking all such trees in sample plots in twenty-one different forests. These trees were recorded under :—

(a) those which could be marked for felling; and

(b) those which should, for sylvicultural reasons, remain.

A similar classification was adopted during the exhaustive valuation surveys which were carried out in 1928/30 when 2,525 acres of sample strips were marked and measured. For the purpose of determining maturity the following diameter limits were adopted in both cases. Outeniqua yellowwood 24in., stinkwood 18in., upright yellowwood 16in., ironwood and white pear 14in., and assegai 12in. The comparative results are shown in table 2.

Table 2.

PERCENTAGE OF MATURE TREES OF VARIOUS SPECIES REMAINING AT 1930.

Species	Percentages of mature or marketable trees.	
	1900	1928-30
Ironwood	17.4	25.0
Upright yellowwood	24.2	13.2
White pear	6.5	3.9
Assegai	18.6	6.4
Stinkwood	13.0	1.7
Outeniqua yellowwood	4.8	1.4
Other species	15.5	48.4
All Species	100.0	100.0

This table brings out very strikingly the detrimental effect of the selection system if it cannot be applied indiscriminately to all timber trees in a forest. Stinkwood, the most valuable species, has been seriously depleted and would probably have been almost exterminated but for the fact that it coppices freely.

The estimated volumes of timber available for exploitation are reflected in table 3.

Table 3.

VOLUME PER SPECIES AVAILABLE FOR EXPLOITATION.

Species	Volume in cubic feet.				
	available 1931-71	removed 1931-39	remaining at 31.3.1939	Average removed annually 1931-39	Average available annually 1939-71
Kamassi	953,210	184,798	768,412	23,099	24,013
B. ironwood	2,060,083	366,255	1,693,827	45,782	52,932
U. yellowwood	1,725,319	621,461	1,103,858	77,683	34,495
Assegai	334,151	125,658	208,493	15,707	6,515
White els	364,463	36,756	327,707	4,594	10,241
White pear	264,624	87,171	177,453	10,896	5,545
Kershout	477,507	45,021	432,486	5,627	13,515
Vlier	104,007	28,053	75,954	3,507	2,373
Stinkwood	139,158	131,046	8,112	16,381	253
Red els	112,787	4,807	107,980	601	3,374
Outeniqua y'wood	829,136	553,964	275,172	69,245	8,599
Beukenhout	102,302	8,573	93,729	1,072	2,929
Hard pear	135,911	29,372	106,539	3,672	3,329
Other species	497,327	15,093	482,234	1,887	15,069
TOTAL	8,099,984	2,238,028	5,861,956	279,753	183,182

This table provides a pointer in regard to the lines of future management. The figures show that the output of kamassi can be maintained at about its present level, that the annual cut of ironwood, white els, kershout, red els, beukenhout and species not enumerated can be increased and that considerable reductions will have to be made in the output of upright yellowwood, assegai, white pear, vlier, stinkwood, Outeniqua yellowwood and hard pear. The most drastic reductions will apply to stinkwood and Outeniqua yellowwood, particularly the former. Endeavours will have to be made to find markets for woods which have hitherto been little in demand and which are now cluttering up the forests to the detriment of more valuable kinds.

Regeneration should be considered in relation to probable future requirements of indigenous timbers. There seems to be little prospect for wagon woods as motor transport has practically killed the wagon and cart making industry. In 1891 the products turned out by this industry were valued at £636,000 a year in the Cape alone but have dwindled to about £61,000 for the whole Union. Ox wagons are not likely to be altogether driven off the roads for some time to come and consequently a certain amount of wagon woods will be needed for replacements and repairs. It seems more than probable that without paying special attention to the propagation of species that yield these woods, ample supplies will be available and probably other uses will have to be found for the surplus. The desirability of propagating a valuable species like stinkwood as extensively as possible and favouring regrowth against other species cannot be questioned. This timber has stood supreme for over 160 years and is likely to remain so. Consideration might also be given to the propagation of other furniture woods such

as red els, white els and beukenhout. Terblans has little to commend it for this purpose. If plain sawn the wood is without figure and if quarter sawn is too florid to become popular.

The conversion of yellowwood into sleepers should be discontinued and available supplies reserved for better uses to which the timber can be put. The remaining few large Outeniquas, relics of a bygone past, are worthy of preservation as objects of botanical interest and for sentimental reasons and aesthetic effects. Some of these giants are probably in the neighbourhood of one thousand years of age and their antiquity should safeguard them from the axe. On account of their very slow growth, it is questionable whether the propagation of yellowwoods would be economically sound but the fact should not be lost sight of that Outeniqua in particular is best suited to the purpose of restoring height growth. Possibly by judicious thinning the rate of growth may be accelerated and knot free timber obtained by resort to artificial pruning.

And what of the many other kinds of timber the forest contains? Possibly some can be converted into handles, strip flooring or floor blocks. May be investigations by the Forest Products Institute will show other uses to which the woods can be put.

What is needed is a clear cut idea of the future composition to be aimed at. The composition may vary from reserve to reserve or forest to forest or even in different parts of a forest. At this stage it is quite impossible to lay down a definite policy. The matter will have to be very carefully considered from all aspects before a decision can be arrived at. At the moment much remains to be done to clear up the aftermath of the sway of the woodcutter.

A KEY TO THE SPECIES OF *EUCALYPTUS* GROWN IN SOUTH AFRICA.

By E. K. Marsh
(Forest Research Officer, Pretoria)

Introduction

THE genus *Eucalyptus* is one of amazing complexity. Over 600 species and varieties have already been described, while others still await description. On account not only of its size, but also of the close inter-relationships of some of the species, the degree of variability within individual species, and a tendency to hybridisation between the species, the identification of the species of this genus usually calls for the examination of very complete herbarium material. Consequently in using the keys at present available, the material required is such that it is unreasonable to expect the practical man, who is most often the person desiring the identification of a given specimen, to have the knowledge or opportunity to collect the necessary specimens, which it is besides frequently impossible to collect at any one time.

About a quarter of the known species and varieties have been introduced into South Africa. These are derived from relatively few seed sources, which may on the whole be expected to represent typical specimens of their species. Many species have been growing here for only a single generation. All the factors which tend to complicate indentification are therefore modified in South Africa and this makes it possible to construct a local key in which the requirements as regards herbarium material are reduced to more practical proportions.

The major divisions of the present key are based on the characteristics of mature leaves and fruits as such material is commonly represented in the majority of specimens submitted. It is possible to identify quite a number of species from this material alone. The identification of the remaining species, however, demands the examination of buds in addition to mature leaves and fruits.

The reduction in the amount of material required results in another practical advantage in that the number of technical terms used is also considerably lessened. The key is thus rendered more readily accessible to the layman.

Many will, no doubt, consider it anomalous that the characteristics of the bark are not used in the key (though they are given in very broad groups in the accompanying schedule of characteristics), as the bark is admittedly the most important single aid to identification in the field. The reason for this omission is to be sought in the fact that the key was designed primarily for use in the herbarium, where it frequently happens that bark specimens are not available or, if available, are of very limited value, as information concerning the position on the tree from which the bark was taken and its nature on other parts of the trunk and branches is generally lacking.

It will also be noted that the key does not directly arrive at the identities of individual species, the ultimate divisions of the key being groups of not more than five species. This again reflects the original object of the key, for at this stage it is obviously preferable to compare authentic specimens in the herbarium, provided that these are limited in number, than to depend further on the use of a key. The illustrative plates and the schedule of characteristics have been devised with the object of fulfilling in part the functions of a herbarium and facilitating determination of the identities of most specimens in the field.

It should be stressed that this key is based on the Eucalypt specimens housed in the Forestry Division's herbarium and that the accuracy of every key depends on the range of material examined. This herbarium undoubtedly contains the most comprehensive collection of Eucalypts in the country, but it is nevertheless to be expected that some atypical specimens will be collected in the field, which will fall outside the range represented in the herbarium and consequently in the key. The writer would be glad to receive any such specimens.

Mention must be made of the fact that the key does not include all the species of Eucalypt known to have been introduced into the country. Approximately a dozen rare species, of which specimens are not at present available, have been omitted, and there may also be others of which the writer has no record. Conversely, some few of the species included may possibly no longer be represented in South Africa.

The writer is greatly indebted to Mr. J. J. Kotze, under whose guidance as Chief Forest Research Officer he was first introduced to the interesting study of Eucalypt identification. The work of those past and present members of the Forestry Division by whose efforts the present herbarium was built up is also acknowledged as a direct contribution to this key. Among former members of this Division, Mr. C. C. Robertson must be specially mentioned for his interest in the introduction and cultivation of Eucalypts and for his valuable contributions to the herbarium. The writer's thanks are also due to Mrs. Marsh for the great deal of time and trouble taken in preparing the illustrations. The following works of reference have been freely consulted: *A Critical Revision of the Genus Eucalyptus* by J. H. Maiden, and *A Key to the Eucalypts,* by W. F. Blakely.

Use of the Key

First consult the key to the Sections. Examine the specimen in respect of the various groups of alternatives in the order in which such groups are encountered. If, opposite the relevant alternative, a number is given on the right-hand side of the page, look for this number on the left-hand side of the page and proceed with the group of alternatives so indicated. If the relevant alternative leads to a Section turn to that Section and proceed as before using the key to the Groups. This leads eventually to a Group, the members of which are given under Representatives of the Groups.

Capitalisation in the groups indicates the included species most commonly encountered; italicization, those less frequently met with, though by no means rare. The remaining species in each group may be left out of consideration, except in special circumstances. These

circumstances are likely to arise only when the specimen has been collected from a trial plot on a Government Forest Station, from the Forestry Division's arboreta (particularly those at Tokai, Robertson, and Kluitjes Kraal), or from a very few of the Public Parks and Gardens. The possibility of encountering these species in private cultivation is remote. Each species in the group is also accorded a number. This number refers to the figure in plates 1 to 8 which illustrates the species. The next step in the identification is therefore to compare the figures for the species in the group arrived at. In the majority of cases only the emphasised species need be compared.

When the relevant figure does not afford a clear distinction between the species, the schedule of characteristics may be consulted. Here the characteristics of each species are given in tabular form. A few of these groups of characteristics will not have been employed in tracing the relevant group of species, and will therefore be available as an aid in separating the members of such a group. The characteristics appropriate to any given species are indicated with a cross (x) on the line devoted to the species concerned. Where two or more alternatives of the same group occur in a single species the underlining of one of them (x) indicates that it is the most common for that species. In other words the underlining can be translated by the word "usually." Where two or more alternatives occur and one is underlined while the others are not, the latter may usually be interpreted as modifying the characteristics for which they are given by the words "lightly," "moderately," "nearly," etc. Therefore if two species, A and B, are listed as follows :—

Species	VALVES	
	Enclosed	Exsert
A	×	×
B		×

they are not necessarily indistinguishable when both are exsert, as A will be only slightly exsert, whereas B will probably be strongly exsert. In the light of extended experience in range and tendency of variations, the reader will, himself, from time to time find occasion to underline additional characteristics.

Example.

The following example, in which a specimen of *E. sideroxylon* is used, illustrates the method of using the key : Turn to the key to the Sections. Determine whether the inflorescence is terminal or axillary. It is axillary—therefore proceed to 3. The umbel is multi-flowered—proceed to 5. The peduncle is terete—proceed to 6. The fruit is pedicellate—proceed to 7. The peduncle is medium in length—proceed to 8. The valves are enclosed—proceed to 11. The fruit is medium in size—proceed to 12. The venation of the leaves is oblique—consult Section XIV.

Now turn to Section XIV. The fruit is longer than broad—proceed to 2. The pedicels of the fruit are longer than the fruit—consult Group 6. Turn to Group 6. It will be seen that the only member is *E. sideroxylon.* Supposing however, as is often the case in this species, that the fruits in the specimen are as long as broad. Then the specimen will fall into Group 10. The specimen must therefore represent *E. Bosistoana* or *E. sideroxylon.* In view of the emphasis the probability is that the species is *E. sideroxylon.* The respective numbers given for these specimens are 16 and 128. Turn to these respective figures in the plates and compare them. It will be seen that there is a distinct difference in the shape and size of the fruits of these species, that of *E. sideroxylon* being usually larger, more gradually tapered at the base where it joins the pedicel, and more constricted at the orifice. Turning to the schedule it is also found that the mature leaves and opercula of *E. Bosistoana* are usually longer than those of *E. sideroxylon,* the pedicels of the fruit usually shorter, and that there is a marked difference in the type of bark.

IMPORTANT POINTS TO BE OBSERVED IN USING THE KEY.

If the key is to be used to the best advantage the following points should also be borne in mind:—

(1) The key refers strictly to the average characteristics of any given specimen except where otherwise stated. In determining the size of the mature leaf, for instance, no attention should be paid to the largest and smallest leaves—only average leaves should be examined. The same applies to the characteristics of fruits and buds. This is particularly important as practically all species of Eucalypts show a marked tendency to variation and in extreme cases individual fruits, buds, or leaves may show characteristics far removed from the average for the specimen.

(2) The material examined should conform to the following developmental stages:—

Leaves—must be mature, as juvenile, seedling, and intermediate leaves show quite different characteristics.

Buds—should be fully developed and ready to shed the operculum. Immature buds will not conform to the characteristics given in the key. If they have to be used in the absence of better material, it is essential to follow up all the alternatives given, which are concerned with bud characteristics.

Fruits—should be examined immediately or soon after they have shed their seeds. If immature fruits are collected, the size and shape may be affected and it is often impossible to determine whether the valves will be exsert or enclosed. Here again at least both the latter possibilities should be followed up in the key. If old fruits from previous seasons have to be used, it must be remembered that terminal inflorescences may become lateral through the subsequent growth of a lateral bud, that the shape of the penduncle may alter as the result of the deposition of a superficial suberose layer, and that the peduncle often shrinks in length with age.

(3) It will be noted that some of the buds illustrated in the plates do not conform to the characteristics given for the species in the schedule. These are immature buds and are included as an aid to identification, when mature buds are not available.

(4) The reference number given in the schedule for each species refers to the relevant figure in the plates. When the reference number is given in brackets after a species, instead of in the first column, this indicates that the species in question is regarded as a synonym of the species indicated by that reference number.

(5) This key does not attempt to distinguish between some of the very closely related species, as it is felt that these species can only be satisfactorily identified with the aid of an herbarium. Such species are :—

E. Stuartiana and *E. Bridgesiana.* One authority regards these as synonymous, but, although they are admittedly very similar botanically, this view cannot be accepted in view of the greater frost-hardiness of the latter. It is also considered that they can be distinguished on the basis of differences in their juvenile foliage.

E. rubida and *E. Dalrympleana.* In typical specimens these are easily distinguishable on account of the glaucousness of the fruits and buds of the former and the fact that the fruits of the latter are the larger, but many intermediate forms appear to occur and these are difficult to identify.

E. grandis and *E. saligna.* There are many atypical forms of these species, which require the careful weighing up of a number of characteristics before the identity can be determined. It has been customary in South Africa to speak of the members of both species as *E. saligna,* but the vast majority of these are actually *E. grandis,* true *E. saligna* being very rarely encountered.

(6) With one exception, all the measurements required for this key can be made on a piece of cardboard or stiff paper cut into the shape of a right-angled triangle with an hypotenuse 2 cms. long (marked out in millimetres) and remaining angles of 60° and 30°. The remaining measurement of 12 cms. can be measured out on the hand, the distance between the basal joint of the thumb and the tip of the forefinger being a close approximation in the writer's case. The length of the average fountain pen often approximates this distance.

With a little practice most measurements can be made by eye, but it should be noted that ratio of length to breadth of the fruit is very deceptive and should preferably be measured.

Definition of Terms.

It is advisable, even if the reader is familiar with the terms used, to study the following definitions, as some of the terms are used in special or restricted senses. The terms are dealt with in the order in which they occur in the schedule, as this is for the most part the order in which they are likely to be encountered in the key.

Type of Inflorescence.

The inflorescence is the reproductive shoot. The term is often used with particular reference to the flowering shoot, but it should be remembered that the disposition of the buds and fruits reflects the disposition of the flowers and it is therefore immaterial whether buds, fruits, or flowers are examined. In Eucalypts the inflorescence consists of solitary (rarely two) umbels borne in the angle between a leaf and a twig (*axillary inflorescence*) or of an aggregation of umbels which terminates the shoot (*terminal inflorescence*). See figs. 150 and 151.

Number of Flowers in the Umbel.

The *umbel* is an inflorescence in which a number of flower stalks spring from the same point at the top of a common stalk. (See fig. 152a). In counting the number of flowers, buds, or fruits, it is important to take into account those that may have fallen off. Their absence is indicated by the presence of pedicel scars (see fig.

152g) at the top of the common stalk (peduncle), and such scars must be taken into account in arriving at the total. It is particularly important in examining apparently 3-flowered umbels to ensure that they are not in reality multi-flowered umbels from which some of the members are missing. Umbels with more than 3 flowers are here termed multi-flowered.

THE SHAPE OF THE PEDUNCLE.

The peduncle (see fig. 152b) is the common stalk which supports the umbel. Its shape in cross-section may be rounded or nearly so (*terete*) or it may be distinctly flattened (*compressed*).

ATTACHMENT OF THE FRUIT.

In most cases the fruits are attached to the top of the peduncle by a stalk, and they are then termed *pedicellate* (see fig. 152c) or more rarely the stalk may be lacking and they are said to be *sessile* (see fig. 152b). Truly sessile fruits are infrequent, as there is usually some vestige of a stalk. If one or more truly sessile fruits are found in the umbel, the whole umbel may be regarded as sessile.

LENGTH OF PEDUNCLE OF FRUITS.

The lengths are arbitrarily divided into 3 classes:—

(1) *long* — more than 2 cms. long.
(2) *medium* — 1 to 2 cms. long.
(3) *short* — less than 1 cm. long.

THE VALVES.

The *valves* are the lids of the chambers which confine the seeds. Valves which protrude after the seed has been liberated are termed *exsert* (see fig. 152e) while those which remain within the orifice of the fruit are said to be *enclosed* (see fig. 152f).

THE SIZE OF THE FRUITS.

The fruit is measured at its widest or longest part, whichever is the greater. In measuring length neither valves (if they are exert) nor pedicel (if present) are included. The size classes are defined as follows:—

(1) *Large* — longest axis 1 cm. or more.
(2) *Medium* — longest axis 0.6 cms. to 1.0 cms. in length.
(3) *Small* — longest axis up to 0.6 cms.

VENATION OF MATURE LEAVES.

Reference is particularly made to the relation of the lateral (secondary) veins with one another and with the midrib. The venation is termed *longitudinal* when one or more of the lateral veins in the middle third of the leaf subtend an angle of 30° or less with the midrib. In the most typical cases (e.g. *E. pauciflora*) the lateral veins tend to run almost parallel to the midrib. This type of venation is further characterised by the fact that few lateral veins arise per inch of mid-rib. See fig. 154.

The venation is *transverse* when the lateral veins of the middle third of the leaf subtend an angle of about 60° with the

midrib. In the present instance, however, less attention has been paid to the angle, though this is usually in the neighbourhood of 60° than to the presence or absence of the condition known as parallel venation, in which the lateral veins are parallel to one another and numerous, i.e. there are a large number of veins per inch of mid-rib. Examples of this type are *E. grandis, E. saligna, E. diversicolor, E. microcorys, E. ficifolia,* etc. Such venation is often described as "fine" (see fig. 154). All transverse-veined leaves are distinctly darker on the upper than on the lower surface—in rare cases oblique-veined leaves also show this phenomenon.

Oblique venation is a type intermediate between the two foregoing types and is the one most frequently encountered (e.g. *E. rostrata, E. sideroxylon, E. globulus, E. viminalis,* etc.)

SIZE OF MATURE LEAVES.

Leaves 12 cms. or less in length are considered to be *short. Long* leaves exceed 12 cms. in length.

SHAPE OF FRUITS.

Here the ratio of the length to the breadth is dealt with. In measuring the length, valves and pedicels are again omitted. Differences between length and breadth of 1 mm. or more are considered to be significant.

LENGTH OF PEDICELS OF FRUITS.

The length of the pedicels of the fruit is compared with the length of the fruit, the length of the latter being defined as before.

SHAPE OF OPERCULUM.

The operculum (fig. 155d) is the lid which covers the stamens in the bud. It is regarded as *hemispherical* (fig. 155a) when it has the general shape of half a tennis ball. A small bump or umbo may be present at the apex and may distort the shape slightly from that of a hemisphere. When the operculum tapers gradually to a point it is termed *conical* (fig. 155b). A small umbo may also be present in this type. Opercula in which the umbo is very pronounced or in which the whole of the operculum is prolonged into a beak or horn are said to be *rostrate.* (fig. 155c).

LENGTH OF OPERCULUM OF BUDS.

The length of the operculum (fig. 155d) is compared with the length of the remaining portion of the bud, excluding the pedicel i.e. with the length of the calyx tube (fig. 155e).

TYPE OF BARK.

This characteristic has not been used in the key, but is given in very broad groups as a useful additional character for field use.

A Smooth-Bark Eucalypt is regarded as one in which the bark is smooth throughout or in which the bark is smooth for the greater part with several feet of rough bark at the base. The bark is usually deciduous and strips off in patches (*E. maculata*) or ribbons (*E. globulus*). The term Gum—occasionally even Blue Gum—is sometimes applied indiscriminately to all Eucalypts by the

uninitiated, but it should, of course, be restricted to Smooth-Bark Eucalypts. All the Gums and most of the Ashes are included in this group.

The name *Half-Bark* or *Hemiphloia* is applied to those Eucalypts in which the bark is partly rough and partly smooth in roughly equal proportions. The rough bark may extend from the base to about half the height of the bole, or to the point at which the first branches arise on the bole, or sometimes even to the main branches. The remainder of the bark is smooth. This gives rise to the name "Gum-topped," as for instance in *E. gigantea* whose common name is Gum-top Stringybark Ash. This group includes the Boxes.

Flaky-Barks are of the rough-barked type. The bark is persistent on the trunk and branches, is lamellar in structure and chips off in flakes. The group is a small one and includes some of the *Corymbosae,* such as *E. ficifolia* and *E. calophylla.*

Iron-barks are species having a rough, deeply-furrowed, somewhat corky bark similar to that of *E. paniculata* and *E. sideroxylon.* The rough bark may be persistent to the small branches or may only extend for the greater part of the bole. This type of bark characterises a small but easily distinguishable group.

The term *Rough-Barked* is reserved for those species in which the rough bark extends to the branches, but whose bark is not characterised by any distinctive structure such as in the other rough-barked groups, e.g. *E. robusta.*

Stringybarks are those rough-barked species in which the bark displays a fibrous texture, e.g. *E. fastigata.*

KEY TO THE SECTIONS.

1.	Inflorescence terminal	2
	Inflorescence axillary	3
2.	Valves exsert	*Section I.*
	Valves enclosed	*Section II.*
3.	Flowers solitary or in pairs	*Section III.*
	Umbels 3-flowered	4
	Umbels multi-flowered	5
4.	Peduncle terete	*Section IV.*
	Peduncle compressed	*Section V.*
5.	Peduncle terete	6
	Peduncle compressed	20
6.	Fruit sessile	*Section VI.*
	Fruit pedicellate	7
7.	Peduncle long (more than 2 cms.)	*Section VII.*
	Peduncle medium (1-2 cms. in length)	8
	Peduncle short (less than 1 cm.)	13
8.	Valves exsert	9
	Valves enclosed	11

9. Fruit large (exceeding 1.0 cms. along its longest axis) *Section VIII.*
Fruit medium (longest axis measures 0.6 to 1.0 cms.) 10
Fruit small (longest axis not exceeding 0.6 cms.) *Section XI.*

10. Venation of mature leaves longitudinal or transverse *Section IX.*
Venation of mature leaves oblique *Section X.*

11. Fruit large (exceeding 1.0 cms. along its longest axis) *Section XII.*
Fruit medium (longest axis measures 0.6 to 1.0 cms.) 12
Fruit small (longest axis not exceeding 0.6 cms.) *Section XVI.*

12. Venation of mature leaves longitudinal *Section XIII.*
Venation of mature leaves oblique *Section XIV.*
Venation of mature leaves transverse *Section XV.*

13. Valves exsert 14
Valves enclosed 17

14. Fruit large (exceeding 1.0 cms. along its longest axis) *Section XVII.*
Fruit medium (longest axis measures 0.6 to 1.0 cms.) 15
Fruit small (longest axis not exceeding 0.6 cms.) 16

15. Venation of mature leaves longitudinal *Section XVIII.*
Venation of mature leaves oblique or transverse *Section XIX.*

16. Venation of mature leaves longitudinal *Section XX.*
Venation of mature leaves oblique or transverse *Section XXI.*

17. Fruit large (exceeding 1.0 cms. along its longest axis) *Section XXII.*
Fruit medium (longest axis measures 0.6 to 1.0 cms.) 18
Fruit small (longest axis not exceeding 0.6 cms.) 19

18. Venation of mature leaves longitudinal *Section XXIII.*
Venation of mature leaves oblique or transverse *Section XXIV.*

19. Venation of mature leaves longitudinal *Section XXV.*
Venation of mature leaves oblique or transverse *Section XXVI.*

20. Fruit sessile *Section XXVII.*
Fruit pedicellate 21

21. Peduncle long (more than 2 cms.) *Section XXVIII.*
Peduncle medium (1—2 cms. in length) 22
Peduncle short (less than 1 cm) 25

22. Valves exsert 23
Valves enclosed *Section XXXIII.*

23. Fruit large (exceeding 1.0 cms. along its longest axis) *Section XXIX.*
Fruit medium (longest axis measures 0.6 to 1.0 cms.) 24
Fruit small (longest axis not exceeding 0.6 cms.) *Section XXXII.*

24. Venation of mature leaves longitudinal or transverse *Section XXX.*
Venation of mature leaves oblique *Section XXXI.*

25. Valves exsert *Section XXXIV.*
Valves enclosed *Section XXXV.*

SECTION I.

Inflorescence terminal, and/or paniculate, and/or corymbose; valves exsert.

KEY TO THE GROUPS.

Venation of mature leaves longitudinal *Group 1.*
Venation of mature leaves oblique *Group 2.*
Venation of mature leaves transverse *Group 3.*

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 2.	Group 3.
9. Andrewsi	81. micrantha	29. Cloeziana
81. micrantha	98. PANICULATA	83. MICROCORYS
112. *crebra*	112. *crebra*	84. microtheca
	127. *siderophloia*	86. ROBUSTA
	143. umbra	121. Rummeryi.

SECTION II.

Inflorescence terminal, and/or paniculate, and/or corymbose; valves enclosed.

KEY TO THE GROUPS.

1. Peduncle long or medium (over 1 cm. in length) 2
   Peduncle short (less than 1 cm. in length) 10

2. Venation of mature leaves longitudinal 3
   Venation of mature leaves oblique 5
   Venation of mature leaves transverse 9

3. Fruit large or medium (longest axis exceeds 0.6 cms. in length) 4
   Fruit small (longest axis not exceeding 0.6 cms.) *Group* 3.

4. Operculum of bud hemispherical *Group* 1.
   Operculum of bud conical *Group* 2.

5. Fruit medium or large (longest axis exceeds 0.6 cms.) 7
   Fruit small (longest axis not exceeding 0.6 cms.) 6

6. Mature leaves short (up to 12 cms. in length) *Group* 7.
   Mature leaves long (more than 12 cms. in length) *Group* 8.

7. Operculum of bud hemispherical *Group* 4.
   Operculum of bud conical or rostrate 8

8. Mature leaves long (more than 12 cms. in length) *Group* 5.
   Mature leaves short (up to 12 cms. in length) *Group* 6.

9. Fruit very large (longest axis exceeds 2.0 cms.) *Group* 9.
   Fruit large or medium (longest axis 0.6 to 2.0 cms.) *Group* 10.
   Fruit small (longest axis up to 0.6 cms.) *Group* 11.

10. Fruit large (longest axis exceeds 1.0 cms.) *Group* 12.
    Fruit medium (longest axis 0.6 to 1.0 cms.) 11
    Fruit small (longest axis not exceeding 0.6 cms.) 17

11. Venation of mature leaves longitudinal 12
    Venation of mature leaves oblique 13
    Venation of mature leaves transverse *Group* 21.

12. Operculum hemispherical *Group* 19.
    Operculum conical or rostrate *Group* 20.

13. Fruit longer than broad 14
    Fruit as long as broad 16
    Fruit broader than long *Group* 18.

14. Operculum of bud hemispherical *Group* 13.
    Operculum of bud conical or rostrate 15

15. Mature leaves broad (more than 2 cms. wide) *Group* 14.
    Mature leaves narrow (up to 2 cms. wide) *Group* 15.

16. Operculum of bud hemispherical — *Group* 16.
Operculum of bud conical or rostrate — *Group* 17.

17. Fruit longer than broad 18
Fruit as broad as or broader than long 22

18. Pedicels of fruit up to half the length of the fruit 19
Pedicels more than half the length of the fruit 21

19. Operculum of bud hemispherical — *Group* 22.
Operculum of bud conical or rostrate 20

20. Operculum of bud shorter than the calyx tube — *Group* 23.
Operculum of bud equal to or slightly longer than calyx tube — *Group* 24.

21. Operculum of bud hemispherical — *Group* 25.
Operculum of bud conical — *Group* 26.

22. Operculum of bud hemispherical — *Group* 27.
Operculum of bud conical or rostrate 23

23. Mature leaves more than 12 cms. long — *Group* 28.
Mature leaves less than 12 cms. long — *Group* 29.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

9. Andrewsi
48. gamophylla
57. haemastoma
87. niphophila (coriacea var, alpina

GROUP 2.

2. affinis
6. *albens*
16. *Bosistoana*
19. Caleyi
81. micrantha

GROUP 3.

9. Andrewsi
57. haemastoma
82. microcarpa
112. *crebra*

GROUP 4.

57. haemastoma
79. melanophloia

GROUP 5.

16. *Bosistoana*
58. hemiphloia
81. micrantha
98. PANICULATA
141. triantha (acmenioides)

GROUP 6.

58. hemiphloia
79. melanophloia
81. micrantha
98. PANICULATA
143. umbra

GROUP 7.

12. Baueriana
57. haemastoma
79. melanophloia
82. microcarpa
112. *crebra*

GROUP 8.

57. haemastoma
141. triantha (acmenioides)

GROUP 9.

20. CALOPHYLLA (seeds not winged, black)
45. FICIFOLIA (seeds winged, brown)

GROUP 10.

28. CLADOCALYX
42. eximia
56. *gummifera* (corymbosa)
83. MICROCORYS
86. ROBUSTA

GROUP 11.

121. Rummeryi

GROUP 12.

20. CALOPHYLLA (seeds black, not winged)
45. FICIFOLIA (seeds brown, winged)
73. MACULATA

GROUP 13.

12. Baueriana
79. melanophloia
106. *polyanthemos*

GROUP 14.

12. Baueriana
58. hemiphloia
79. melanophloia
98. PANICULATA
106. *polyanthemos*

GROUP 15.

79. melanophloia
94. odorata
98. PANICULATA
106. *polyanthemos*

GROUP 16.

12. Baueriana
61. jugalis

GROUP 17.

12. Baueriana
16. *Bosistoana*
80. MELLIODORA
94. odorata
98. PANICULATA

GROUP 18.

81. micrantha

GROUP 19.

9. Andrewsi
48. gamophylla
81. micrantha
106. *polyanthemos*

GROUP 20.

16. *Bosistoana*
80. MELLIODORA
81. micrantha
106. *polyanthemos*

GROUP 21.

27. *citriodora* (leaves lemon-scented)
29. Cloeziana
73. MACULATA (leaves not lemon-scented)
83. MICROCORYS

GROUP 22.

12. Baueriana
13. Beyeri
14. bicolor
106. *polyanthemos*

GROUP 23.

12. Baueriana
13. Beyeri
31. conica
106. *polyanthemos*

GROUP 24.

82. microcarpa
94. odorata
102. pilligaensis

GROUP 25.

9. Andrewsi
14. bicolor
79. melanophloia
107. populifolia

GROUP 26.

31. conica
79. melanophloia
82. microcarpa
94. odorata
102. pilligaensis

GROUP 27.

9. Andrewsi
12. Baueriana
14. bicolor
107. populifolia

GROUP 28.

80. MELLIODORA

GROUP 29.

12. Baueriana
31. conica
82. microcarpa
94. odorata
112. *crebra*

SECTION III.

Inflorescence axillary; fruits solitary or in pairs.

50. GLOBULUS
71. microcarpa
136. tetraptera

SECTION IV.

Inflorescence axillary; umbels 3-flowered; peduncles of fruits terete.

KEY TO THE GROUPS.

1. Fruit sessile — *Group* 1.
   Fruit pedicellate 2

2. Valves exsert — *Group* 2.
   Valves enclosed — *Group* 3.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

26. CINEREA
34. *Dalrympleana*
119. *rubida*

GROUP 2.

26. CINEREA
34. *Dalrympleana*
110 A. pyriformis
119. *rubida*
145. VIMINALIS

GROUP 3.

61. jugalis
65. *leucoxylon*
69. *longifolia*
110 A. pyriformis
144. urnigera

SECTION V.

Inflorescence axillary; umbels 3-flowered; peduncles of fruits compressed.

KEY TO THE GROUPS.

1. Fruit sessile 2
   Fruit pedicellate 4

2. Valves exsert 3
   Valves enclosed *Group* 3.

3. Fruit large (longest axis exceeds 1.0 cms.) *Group* 1.
   Fruit medium or small (longest axis 1.0 cms. or less) *Group* 2.

4. Valves exsert 5
   Valves enclosed *Group* 6.

5. Fruit large (longest axis exceeds 1.0 cms.) *Group* 4.
   Fruit medium or small (longest axis 1.0 cms. or less) *Group* 5.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 3.	Group 5.
50. GLOBULUS	33. cosmophylla	26. CINEREA
60. insizwaensis	60. insizwaensis	34. *Dalrympleana*
78. megacarpa	78. megacarpa	145. VIMINALIS

Group 2.	Group 4.	Group 6.
26. CINEREA		
34. *Dalrympleana*	23. canaliculata	65. *leucoxylon*
109. pulverulenta	101. pellita	135. tetragona
145. VIMINALIS	110 A. pyriformis	144. urnigera

SECTION VI.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit sessile.

KEY TO THE GROUPS.

1. Peduncles long (exceeding 2 cms.) 2
   Peduncles medium (1-2 cms. in length) 3
   Peduncles short (not exceeding 1 cm.) 8

2. Valves exsert *Group* 1.
   Valves enclosed *Group* 2.

3. Valves exsert 4
   Valves enclosed 6

4. Fruit medium or large (longest axis exceeds 0.6 cms.) 5
   Fruit small (longest axis up to 0.6 cms.) *Group* 6.

5. Fruit longer than broad *Group* 3.
   Fruit as long as broad *Group* 4.
   Fruit broader than long *Group* 5.

6. Fruits crowded in dense, compact heads *Group* 7.
   Fruits not crowded in the umbel 7

7. Fruit longer than broad — *Group* 8.
   Fruit as long as broad — *Group* 9.
   Fruit broader than long — *Group* 10.

8. Valves exsert 9
   Valves enclosed 15

9. Fruit crowded in dense, compact heads — *Group* 11.
   Fruit not crowded in the umbel 10

10. Fruit medium or large (longest axis 0.6 cms. or more) 12
    Fruit small (longest axis less than 0.6 cms.) 11

11. Valves strongly exsert — *Group* 16.
    Valves slightly exsert — *Group* 17.

12. Fruit broader than long 13
    Fruit as long as, or longer than broad 14

13. Valves slightly exsert — *Group* 12.
    Valves strongly exsert — *Group* 13.

14. Valves slightly exsert — *Group* 14.
    Valves strongly exsert — *Group* 15.

15. Fruit medium or large (longest axis 0.6 cms. or more) 16
    Fruit small (longest axis less than 0.6 cms.) — *Group* 22.

16. Fruit crowded into dense, compact heads — *Group* 18.
    Fruit not crowded in the umbel 17

17. Mature leaves up to 0.5 cms. broad — *Group* 19.
    Mature leaves exceeding 0.5 cms. in breadth 18

18. Mature leaves more than 12 cms. long — *Group* 20.
    Mature leaves less than 12 cms. long — *Group* 21.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

24. capitellata
32. CORNUTA
37. decipiens

GROUP 2.

24. capitellata
37. decipiens

GROUP 3.

25. *cephalocarpa* (cinerea var. multiflora)
32. CORNUTA
40. elaeophora

GROUP 4.

25. *cephalocarpa* (cinerea var. multiflora)
35. dealbata
37. decipiens
40. elaeophora
126. *scabra* (eugenioides)

GROUP 5.

24. capitellata
35. dealbata
37. decipiens
63. laevopinea
126. *scabra* (eugenioides)

GROUP 6.

70. *Macarthuri*

GROUP 7.

3. agglomerata
24. capitellata
37. decipiens

GROUP 8.

6. *albens*
17. *botryoides*
40. elaeophora
79. melanophloia
91. *obliqua*

GROUP 9.

40. elaeophora
87. niphophila (coriacea var. alpina)
91. *obliqua*
126. *scabra* (eugenioides)

GROUP 10.

63. laevopinea
87. niphophila (coriacea var. alpina)
126. *scabra* (eugenioides)

GROUP 11.

7. *alpina*
24. capitellata
40. elaeophora

GROUP 12.

37. decipiens
63. laevopinea
97. *ovata*
126. *scabra* (eugenioides)

GROUP 13.

7. *alpina*
35. dealbata
37. decipiens

GROUP 14.

37. decipiens
88. nitens
89. nitida
97. *ovata*
126. *scabra* (eugenioides)

GROUP 15.

25. *cephalocarpa* (cinerea var. multiflora)
37. decipiens
133. *Stuartiana*

GROUP 16.

25. *cephalocarpa* (cinerea var. multiflora)
70. *Macarthuri*
111. quadrangulata
133. *Stuartiana*

GROUP 17.

88. nitens
97. *ovata*

GROUP 18.

3. agglomerata
24. capitellata
40. elaeophora

GROUP 19.

67. linearis

GROUP 20.

17. *botryoides*
63. laevopinea
88. nitens
91. *obliqua*
126. *scabra* (eugenioides)

GROUP 21.

37. decipiens
79. melanophloia
89. nitida
97. *ovata*

GROUP 22.

67. linearis
79. melanophloia
88. nitens
97. *ovata*
131. stellulata

SECTION VII.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncles long.

KEY TO THE GROUPS.

1. Valves exsert 2
   Valves enclosed 3

2. Fruit small (longest axis less than 0.6 cms.) *Group* 1.
   Fruit medium or large (longest axis exceeds 0.6 cms). *Group* 2.

3. Fruit medium (longest axis 0.6-1.0 cms.) *Group* 3.
   Fruit large (longest axis exceeds 1.0 cms.) 4

4. Venation of mature leaves transverse *Group* 4.
   Venation of mature leaves longitudinal or oblique *Group* 5.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

8. *amplifolia*
68. longicornis

GROUP 2.

11. Baileyana
32. CORNUTA
41. erythronema
55. grandis var. grandiflora
62. *Kirtoniana*

GROUP 3.

28. CLADOCALYX
38. DIVERSICOLOR
49. *gigantea*

GROUP 4.

28. CLADOCALYX
38. DIVERSICOLOR
69A. *longifolia var. multiflora*
77. marginata

GROUP 5.

49. *gigantea*
138. torquata

SECTION VIII.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncles medium (1-2 cms. long); fruit large (longest axis > 1 cms.); valves exsert.

KEY TO THE GROUPS.

1. Venation of mature leaves longitudinal or oblique 2
   Venation of mature leaves transverse *Group* 3.

2. Mature leaves more than 12 cms. long *Group* 1.
   Mature leaves less than 12 cms. long *Group* 2.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 2.	Group 3.
62. *Kirtoniana*	32. CORNUTA	11. Baileyana
63. laevopinea	41. erythronema	55. grandis var. grandiflora
72. *macrorrhynca*	72. *macrorrhynca*	62. *Kirtoniana*
85. *Muelleriana*	120. rudis	
120. rudis		

SECTION IX.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncles medium (1-2 cms. long); fruit medium (longest axis 0.6 to 1.0 cms.); valves exsert; venation of mature leaves longitudinal or transverse.

KEY TO THE GROUPS.

1. Venation of mature leaves longitudinal 3
   Venation of mature leaves transverse 2

2. Operculum of bud shorter than or equal to calyx tube *Group* 8.
   Operculum of bud much longer than calyx tube *Group* 9.

3. Fruit longer than broad *Group* 1.
   Fruit as long as broad 4
   Fruit broader than long 5

4. Valves slightly exsert *Group* 2.
   Valves strongly exsert *Group* 3.

5. Pedicels of fruit up to half length of fruit 6
   Pedicels of fruit from ½-1 x length of fruit *Group* 6.
   Pedicels of fruit longer than the fruit *Group* 7.

6. Valves slightly exsert *Group* 4.
   Valves strongly exsert *Group* 5.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 3.	Group 5.
9. Andrewsi	25. *cephalocarpa* (cinerea var. multiflora)	35. dealbata
25. *cephalocarpa* (cinerea var. multiflora)	35. dealbata	72. *macrorrhynca*
44. *fastigata*	130. *Smithii*	
115. *regnans*	140. transcontinentalis	
140. transcontinentalis		Group 6.
Group 2.	**Group 4.**	44. *fastigata*
		85. *Muelleriana*
9. Andrewsi	44. *fastigata*	130. *Smithii*
39. dives	63. laevopinea	
44. *fastigata*	63A. laevopinea var. minor	Group 7.
63A. laevopinea var. minor	85. *Muelleriana*	
126. *scabra* (eugenioides)	126. *scabra* (eugenioides)	81. micrantha

GROUP 8.	GROUP 9.
54. GRANDIS	15. Blakelyi
55. grandis var. grandiflora	62. *Kirtoniana*
62. *Kirtoniana*	139. Trabuti
83. MICROCORYS	
123. *saligna*	

SECTION X.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncles medium (1-2 cms. long); fruit medium (longest axis 0.6 to 1.0 cms.); valves exsert; venation of mature leaves oblique.

KEY TO THE GROUPS.

1.	Fruit longer than broad	2
	Fruit as long as broad	4
	Fruit broader than long	11
2.	Pedicels of fruits up to ½ length of fruit	*Group* 1.
	Pedicels of fruits ½-1 x length of fruit	3
	Pedicels of fruits longer than fruit	*Group* 4.
3.	Operculum of buds conical	*Group* 2.
	Operculum of buds rostrate	*Group* 3.
4.	Pedicels of fruits up to ½ length of fruit	5
	Pedicels of fruits ½-1 x length of fruit	6
	Pedicels of fruits longer than fruit	*Group* 13.
5.	Valves strongly exsert	*Group* 5.
	Valves slightly exsert	*Group* 6.
6.	Operculum of buds rostrate	7
	Operculum of buds conical	8
7.	Valves strongly exsert	*Group* 7.
	Valves slightly exsert	*Group* 8.
8.	Operculum of buds shorter than the calyx tube	*Group* 9.
	Operculum of buds as long as or longer than calyx tube	9
9.	Valves strongly exsert	10
	Valves slightly exsert	*Group* 12.
10.	Mature leaves more than 12 cms. long	*Group* 10.
	Mature leaves up to 12 cms. long	*Group* 11.
11.	Pedicels of fruit up to ½ length of fruit	12
	Pedicels of fruit ½-1 x length of fruit	14
	Pedicels of fruit longer than the fruit	*Group* 20.
12.	Operculum of buds conical or rostrate	13
	Operculum of buds hemispherical	*Group* 16.
13.	Valves strongly exsert	*Group* 14.
	Valves slightly exsert	*Group* 15.
14.	Operculum of buds rostrate	*Group* 17.
	Operculum of buds conical or hemispherical	15
15.	Valves strongly exsert	*Group* 18.
	Valves slightly exsert	*Group* 19.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

25. *cephalocarpa* (cinerea var. multiflora)
32. CORNUTA
53. *goniocalyx*
95. oleosa

GROUP 2.

53. *goniocalyx*
95. oleosa
127. *siderophloia*

GROUP 3.

15. Blakelyi
62. *Kirtoniana*
95. oleosa
127. *siderophloia*
140. transcontinentalis

GROUP 4.

127. *sidcrophloia*

GROUP 5.

18. BRIDGESIANA
25. *cephalocarpa* (cinerea var. multiflora)
35. dealbata
59. HUBERIANA (multi-flowered viminalis)
95. oleosa

GROUP 6.

63A. laevopinea var. minor
126. *scabra (eugenioides)*

GROUP 7.

8. *amplifolia*
15. Blakelyi
21. CAMALDULENSIS (rostrata)
95. oleosa
140. transcontinentalis

GROUP 8.

5. alba

GROUP 9.

5. alba
130. *Smithii*

GROUP 10.

8. *amplifolia*
18. BRIDGESIANA
22. camphora
43. exserta
130. *Smithii*

GROUP 11.

8. *amplifolia*
22. camphora
95. oleosa

GROUP 12.

5. alba

GROUP 13.

21. CAMALDULENSIS (rostrata)
22. camphora
127. *siderophloia*

GROUP 14.

18. BRIDGESIANA
35. dealbata
59. HUBERIANA (multi-flowered viminalis)
72. *macrorrhynca*

GROUP 15.

85. *Muelleriana*
126. *scabra* (eugenioides)

GROUP 16.

63. laevopinea
63A. laevopinea var. minor
85. *Muelleriana*

GROUP 17.

5. alba
8. *amplifolia*
21. CAMALDULENSIS (rostrata)
120. rudis
139. Trabuti

GROUP 18.

8. *amplifolia*
18. BRIDGESIANA
120. rudis
130. *Smithii*
142. *tereticornis*

GROUP 19.

5. alba
85. *Muelleriana*

GROUP 20.

21. CAMALDULENSIS (rostrata)
81. micrantha
120. rudis
139. Trabuti

SECTION XI.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncle medium (1-2 cms. long); valves exsert; fruit small (longest axis not exceeding 0.6 cms.).

KEY TO THE GROUPS.

1. Venation of mature leaves longitudinal ... *Group* 1.
   Venation of mature leaves oblique 2
   Venation of mature leaves transverse ... *Group* 7.

2. Operculum of buds conical 3
   Operculum of buds rostrate *Group* 6.

3. Operculum of buds much longer than calyx tube *Group* 2.
   Operculum of buds equal to or shorter than calyx tube 4

4. Pedicels of fruits up to ½ length of fruit *Group* 3.
   Pedicels of fruits more than ½ length of fruit 5

5. Valves strongly exsert *Group* 4.
   Valves slightly exsert *Group* 5.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

9. Andrewsi
25. *cephalocarpa* (cinerea var. multiflora)
39. dives
112. *crebra*
118. Robertsoni

GROUP 2.

8. *amplifolia*
43. exserta
59. HUBERIANA (multi-flowered viminalis)
68. longicornis
118. Robertsoni

GROUP 3.

18. BRIDGESIANA
25. *cephalocarpa* (cinerea var. multiflora)
59. HUBERIANA (multi-flowered viminalis)
70. *Macarthuri*
118. Robertsoni

GROUP 4.

18. BRIDGESIANA
22. camphora
25. *cephalocarpa* (cinerea var. multiflora)
59. HUBERIANA (multi-flowered viminalis)
124. salmonophloia

GROUP 5.

118. Robertsoni

GROUP 6.

8. *amplifolia*
15. Blakelyi
21. CAMALDULENSIS (rostrata)
118. Robertsoni

GROUP 7.

15. Blakelyi
36. Deanei

SECTION XII.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncle medium (1-2 cms.); valves enclosed; fruit large (longest axis > 1 cm.).

KEY TO THE GROUPS.

1. Venation of mature leaves longitudinal 2
   Venation of mature leaves oblique 3
   Venation of mature leaves transverse *Group* 5.

2. Mature leaves more than 12 cms. long *Group* 1.
   Mature leaves up to 12 cms. long *Group* 2.

3. Valves almost exsert *Group* 3.
   Valves deeply enclosed *Group* 4.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

6. *albens*
49. *gigantea*
63. laevopinea
87. niphophila (coriacea var. alpina)
129. *Sieberiana*

GROUP 2.

87. niphophila (coriacea var. alpina)
92. obtusiflora

GROUP 3.

63. laevopinea
85. *Muelleriana*

GROUP 4.

99. patens
128. SIDEROXYLON
137. Todtiana
138. torquata
144. urnigera

GROUP 5.

28. CLADOCALYX
38. DIVERSICOLOR
77. marginata

SECTION XIII.

Inflorescence axillary; umbels multi-flowered; peduncle of fruit terete; fruit pedicellate; peduncle medium (1-2 cms. long); valves enclosed; fruit medium (longest axis 0.6 to 1.0 cms.); venation of mature leaves longitudinal.

KEY TO THE GROUPS.

1. Fruit longer than broad 2
   Fruit as long as broad 7
   Fruit broader than long 11

2. Pedicels of fruits up to ½ length of fruit 3
   Pedicels of fruits ½-1 x length of fruit 6
   Pedicels of fruits longer than fruit *Group* 8.

3. Operculum of buds hemispherical 4
   Operculum of buds conical *Group* 4.

4. Length of mature leaves up to 3 x breadth *Group* 1.
   Length of mature leaves more than 3 x breadth 5

5. Mature leaves more than 12 cms. long *Group* 2.
   Mature leaves up to 12 cms. long *Group* 3.

6. Operculum of buds hemispherical *Group* 5.
   Operculum of buds conical *Group* 6.
   Operculum of buds rostrate *Group* 7.

7. Pedicels of fruits up to ½ length of fruit 8
   Pedicels of fruits ½-1 x length of fruit *Group* 13.
   Pedicels of fruits longer than fruit *Group* 14.

8. Operculum of buds hemispherical 9
   Operculum of buds conical *Group* 12.

9. Length of mature leaves up to 3 x breadth *Group* 9.
   Length of mature leaves more than 3 x breadth 10

10. Mature leaves up to 1 cm. in breadth *Group* 11.
    Mature leaves exceeding 1 cm. in breadth *Group* 10.

11. Operculum of buds hemispherical 12
    Operculum of buds conical *Group* 17.

12. Mature leaves more than 12 cms. long *Group* 15.
    Mature leaves up to 12 cms. long *Group* 16.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

100. *pauciflora* (coriacea)
117. Risdoni
134. tasmanica (Risdoni var. elata)

GROUP 2.

57. haemastoma
91. *obliqua*
100. *pauciflora* (coriacea)
115. *regnans*
129. *Sieberiana*

GROUP 3.

46. foecunda
57. haemastoma
100. *pauciflora* (coriacea)

GROUP 4.

6. *albens*
30. congener
100. *pauciflora* (coriacea)
104. piperita
115. *regnans*

GROUP 5.

9. Andrewsi
49. *gigantea*
91. *obliqua*
129. *Sieberiana*

GROUP 6.

2. affinis
104. piperita

GROUP 7.

140. transcontinentalis

GROUP 8.

19. Caleyi

GROUP 9.

117. Risdoni
134. tasmanica (Risdoni var. elata)

GROUP 10.

39. dives
57. haemastoma
87. niphophila (coriacea var. alpina)
91. *obliqua*
147. vitrea

GROUP 11.

132. stricta

GROUP 12.

30. congener
47. *fraxinoides*
100. *pauciflora* (coriacea)
126. *scabra* (eugenioides)
147. vitrea

GROUP 13.

16. *Bosistoana*
91. *obliqua*
140. transcontinentalis

GROUP 14.

16. *Bosistoana*

GROUP 15.

63. laevopinea
81. micrantha
87. niphophila (coriacea var. alpina)
134. tasmanica (Risdoni var. elata)
147. vitrea

GROUP 16.

81. micrantha
87. niphophila (coriacea var. alpina)
117. Risdoni
134. tasmanica (Risdoni var. elata)

GROUP 17.

47. *fraxinoides*
81. micrantha
126. *scabra* (eugenioides)
147. vitrea

SECTION XIV.

Inflorescence axillary; umbels multi-flowered; peduncles of fruits terete; fruit pedicellate; peduncle medium (1-2 cms. long); fruit medium (0.6 to 1.0 cms. in longest direction); valves enclosed; venation of mature leaves oblique.

KEY TO THE GROUPS.

1. Fruit longer than broad 2
   Fruit as long as broad 5
   Fruit broader than long 7

2. Pedicels of fruit up to ½ length of fruit 3
   Pedicels of fruit ½-1 x length of fruit 4
   Pedicels of fruit longer than fruit *Group* 6.

3. Operculum of buds hemispherical *Group* 1.
   Operculum of buds conical or rostrate *Group* 2.

4. Operculum of buds hemispherical *Group* 3.
   Operculum of buds conical *Group* 4.
   Operculum of buds rostrate *Group* 5.

5. Pedicels of fruit up to ½ length of fruit 6
   Pedicels of fruit ½-1 x length of fruit *Group* 9.
   Pedicels of fruit longer than fruit *Group* 10.

6. Operculum of buds hemispherical *Group* 7.
   Operculum of buds conical or rostrate *Group* 8.

7. Pedicels of fruit up to ½ length of fruit *Group* 11.
   Pedicels of fruit ½-1 x length of fruit *Group* 12.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 5.	Group 9.
57. haemastoma	95. oleosa	16. *Bosistoana*
91. *obliqua*	140. transcontinentalis	91. *obliqua*
		95. oleosa
		140. transcontinentalis

Group 2.	Group 6.	Group 10.
53. *goniocalyx*	128. SIDEROXYLON	16. *Bosistoana*
95. oleosa		128. SIDEROXYLON
104. piperita		

Group 3.	Group 7.	Group 11.
	57. haemastoma	63. laevopinea
	91. *obliqua*	85. *Muelleriana*
91. *obliqua*	99. patens	126. *scabra* (eugenioides)

Group 4.	Group 8.	Group 12.
53. *goniocalyx*	95. oleosa	81. micrantha
79. melanophloia	99. patens	85. *Muelleriana*
95. oleosa	126. *scabra* (eugenioides)	
104. piperita		

SECTION XV.

Inflorescence axillary; umbels multi-flowered; peduncles of fruits terete; fruit pedicellate; peduncle medium (1-2 cms. long) fruit medium (0.6-1.0 cms. in longest direction); valves enclosed; venation of mature leaves transverse.

17. *botryoides*
28. CLADOCALYX
38. DIVERSICOLOR
83. MICROCORYS

SECTION XVI.

Inflorescence axillary; umbels multi-flowered; peduncle of fruit terete; fruit pedicellate; peduncle medium (1-2 cms. long); valves enclosed; fruit small (longest axis not exceeding 0.6 cms.).

KEY TO THE GROUPS.

1. Venation of mature leaves longitudinal 2
   Venation of mature leaves oblique *Group* 3.
   Venation of mature leaves transverse *Group* 4.

2. Mature leaves more than 12 cms. long *Group* 1.
   Mature leaves up to 12 cms. long *Group* 2.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 2.	Group 3.
9. Andrewsi	9. Andrewsi	57. haemastoma
30. congener	39. dives	118. Robertsoni
39. dives	46. foecunda	
118. Robertsoni	104. piperita	Group 4.
		36. Deanei

SECTION XVII.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncle short (< 1 cm. long); valves exsert; fruit large (longest axis > 1 cm.).

63. laevopinea
72. *macrorrhynca*
120. rudis

SECTION XVIII.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncle short (< 1 cm. long); valves exsert; fruit medium (longest axis 0.6 to 1.0 cms.); venation of mature leaves longitudinal.

KEY TO THE GROUPS.

1. Fruit longer than broad 2
   Fruit as long as broad 3
   Fruit broader than long 5

2. Valves strongly exsert — *Group* 1.
   Valves slightly exsert — *Group* 2.

3. Operculum of buds hemispherical 4
   Operculum of buds conical or rostrate — *Group* 5.

4. Valves slightly exsert — *Group* 3.
   Valves strongly exsert — *Group* 4.

5. Pedicels of fruits as long as or shorter than the fruit 6
   Pedicels of fruits longer than the fruit — *Group* 8.

6. Operculum of buds hemispherical — *Group* 6.
   Operculum of buds conical or rostrate — *Group* 7.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

25. *cephalocarpa* (cinerea var. multiflora)
140. transcontinentalis

GROUP 2.

9. Andrewsi
44. *fastigata*
89. nitida
113. *radiata*
115. *regnans*

GROUP 3.

9. Andrewsi
39. dives
44. *fastigata*
89. nitida
113. *radiata*

GROUP 4.

76. *mannifera* (multi-flowered rubida)

GROUP 5.

44. *fastigata*
76. *mannifera* (multi-flowered rubida)
126. *scabra* (eugenioides)
133. *Stuartiana*
140. transcontinentalis

GROUP 6.

44. *fastigata*
63. laevopinea
113. *radiata*

GROUP 7.

35. dealbata
44. *fastigata*
72. *macrorrhynca*
126. *scabra* (eugenioides)

GROUP 8.

81. micrantha

SECTION XIX.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncles short (< 1 cm. long); valves exsert; fruit medium (longest axis 0.6 to 1.0 cms.); venation of mature leaves oblique or transverse.

KEY TO THE GROUPS.

1. Venation of mature leaves oblique 2
   Venation of mature leaves transverse *Group* 13.

2. Fruit longer than broad *Group* 1.
   Fruit as broad as long 3
   Fruit broader than long 8

3. Pedicels of fruit up to ½ length fruit 4
   Pedicels of fruit ½-1 x length of fruit 7
   Pedicels of fruit longer than fruit *Group* 8.

4. Mature leaves ovate *Group* 2.
   Mature leaves lanceolate 5

5. Operculum of buds conical or hemispherical 6
   Operculum of buds rostrate *Group* 5.

6. Mature leaves longer than 12 cms. *Group* 3.
   Mature leaves up to 12 cms. long *Group* 4.

7. Operculum of buds as long as or slightly longer than the calyx tube
   Operculum of buds 1½ or more times the length of the calyx tube *Group* 7.

8. Pedicels of fruit up to ½ length of fruit *Group* 9.
   Pedicels of fruit ½-1 x length of fruit 9
   Pedicels of fruit longer than fruit *Group* 12.

9. Operculum of buds as long as or slightly longer than the calyx tube
   Operculum of buds 1½ or more times the length of the calyx tube *Group* 11.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

25. *cephalocarpa* (cinerea var. multiflora)
95. oleosa
127. *siderophloia*
140. transcontinentalis

GROUP 2.

97. *ovata*

GROUP 3.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
76. *mannifera* (multi-flowered rubida)
126. *scabra* (eugenioides)
133. *Stuartiana*

GROUP 4.

95. oleosa

GROUP 5.

59. HUBERIANA (multi-flowered viminalis)
95. oleosa
140. transcontinentalis

GROUP 6.

18. BRIDGESIANA
22. camphora
59. HUBERIANA (multi-flowered viminalis)
95. oleosa
97. *ovata*

GROUP 7.

21. CAMALDULENSIS (rostrata)
43. exserta
127. *siderophloia*
140. transcontinentalis
142. *tereticornis*

GROUP 8.

21. CAMALDULENSIS (rostrata)
22. camphora
127. *siderophloia*

GROUP 9.

35. dealbata
59. HUBERIANA (multi-flowered viminalis)
72. *macrorrhynca*
97. *ovata*
126. *scabra* (eugenioides)

GROUP 10.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
97. *ovata*

Group 11.	Group 12.	Group 13.
21. CAMALDULENSIS (rostrata)	21. CAMALDULENSIS (rostrata)	29. Cloeziana
120. rudis	81. micrantha	83. MICROCORYS
142. *tereticornis*	120. rudis	

SECTION XX

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncles short (< 1 cm. long); valves exsert; fruit small (longest axis not exceeding 0.6 cms.); venation of mature leaves longitudinal.

KEY TO THE GROUPS.

1. Fruit longer than broad — *Group* 1.
   Fruit as long as broad... 2
   Fruit broader than long — *Group* 5.

2. Pedicels of fruit up to ½ length of fruit 3
   Pedicels of fruit more than ½ length of fruit — *Group* 4.

3. Operculum of buds hemispherical — *Group* 2.
   Operculum of buds conical — *Group* 3.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 3.	Group 5.
9. Andrewsi	4. aggregata	90. nova-anglica
25. *cephalocarpa* (cinerea var. multiflora)	90. nova-anglica	113. *radiata*
113. *radiata*	118. Robertsoni	
	133. *Stuartiana*	
	149. yarraensis	

Group 2.	Group 4.
4. aggregata	
39. dives	9. Andrewsi
76. *mannifera* (multi-flowered rubida)	113. *radiata*
90. nova-anglica	118. Robertsoni
113. *radiata*	149. yarraensis

SECTION XXI.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncles short (< 1 cm. long); valves exsert; fruit small (longest axis not exceeding 0.6 cms.); venation of mature leaves oblique or transverse.

KEY TO THE GROUPS.

1. Venation of mature leaves longitudinal or oblique 2
   Venation of mature leaves transverse — *Group* 16.

2. Fruit longer than broad — *Group* 1.
   Fruit as long as broad 3
   Fruit broader than long 10

3. Pedicels of fruit up to ½ length of fruit 4
   Pedicels of fruit ½-1 x length of fruit 8
   Pedicels of fruit longer than fruit — *Group* 10.

4. Valves slightly exsert (only the tips showing) — *Group* 2.
   Valves strongly exsert 5

5. Operculum of bud longer than calyx tube *Group* 3.
Operculum of bud equal to or shorter than calyx tube 6

6. Mature leaves up to 12 cms. long *Group* 4.
Mature leaves more than 12 cms. long 7

7. Mature leaves up to 2 cms. broad *Group* 5.
Mature leaves more than 2 cms. broad *Group* 6.

8. Valves slightly exsert (only the tips showing) *Group* 9.
Valves strongly exsert 9

9. Operculum of buds about equal to calyx tube in length *Group* 7.
Operculum of buds much longer than calyx tube *Group* 8.

10. Pedicels of fruits up to ½ length of fruits 11
Pedicels of fruits ½-1 x length of fruits 12
Pedicels of fruits longer than fruits *Group* 15.

11. Valves strongly exsert *Group* 11.
Valves slightly exsert (only tips showing) *Group* 12.

12. Operculum of buds about equal in length to calyx tube *Group* 13.
Operculum of buds much longer than calyx tube *Group* 14.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

1. acaciaeformis
25. *cephalocarpa* (cinerea var. multiflora)
111. quadrangulata

GROUP 2.

1. acaciaeformis
90. nova-anglica
97. *ovata*
118. Robertsoni
149. yarraensis

GROUP 3.

43. exserta
59. HUBERIANA (multi-flowered viminalis)
133. *Stuartiana*

GROUP 4.

70. *Macarthuri*
74. maculosa

GROUP 5.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
74. maculosa
90. nova-anglica
133. *Stuartiana*

GROUP 6.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
74. maculosa
76. *mannifera* (multi-flowered rubida)
133. *Stuartiana*

GROUP 7.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
124. salmonophloia

GROUP 8.

8. *amplifolia*
21. CAMALDULENSIS (rostrata)
68. longicornis

GROUP 9.

22. camphora
97. *ovata*
112. *crebra*
118. Robertsoni
149. yarraensis

GROUP 10.

21. CAMALDULENSIS (rostrata)
22. camphora
112. *crebra*

GROUP 11.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
70. *Macarthuri*
74. maculosa
90. nova-anglica

GROUP 12.

97. *ovata*
70. *Macarthuri*

GROUP 13.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
97. *ovata*
124. salmonophloia

GROUP 14.

8. *amplifolia*
21. CAMALDULENSIS (rostrata)

GROUP 15.

21. CAMALDULENSIS (rostrata)

GROUP 16.

84. microtheca
121. Rummeryi

SECTION XXII.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncle short (< 1 cm. long); valves enclosed; fruit large (longest axis exceeding 1 cm.).

KEY TO THE GROUPS.

1. Fruit very large (longest axis exceeding 1.5 cms) *Group* 1.
   Fruit large (longest axis 1.0 to 1.5 cms) 2

2. Venation of mature leaves oblique or transverse *Group* 2.
   Venation of mature leaves longitudinal *Group* 3.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 2.	Group 3.
137. Todtiana	63. laevopinea	63. laevopinea
	77. marginata	92. obtusiflora
	99. patens	129. *Sieberiana*
	128. SIDEROXYLON	
	144. urnigera	

SECTION XXIII.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncle short (< 1 cm. long); valves enclosed; fruit medium (longest axis 0.6 to 1.0 cms.); venation of mature leaves longitudinal.

KEY TO THE GROUPS.

1. Fruit longer than broad 2
   Fruit as long as broad 7
   Fruit broader than long 12

2. Pedicels of fruit up to ½ length of fruits 3
   Pedicels of fruits longer than ½ length of fruits 6

3. Operculum of buds hemispherical 4
   Operculum of buds conical or rostrate *Group* 4.

4. Umbels usually in pairs *Group* 1.
   Umbels not in pairs 5

5. Mature leaves short (up to 12 cms. in length) *Group* 2.
   Mature leaves long (more than 12 cms. long) *Group* 3.

6. Operculum of buds hemispherical *Group* 5.
   Operculum of buds conical *Group* 6.
   Operculum of buds rostrate *Group* 7.

7. Pedicels of fruit up to ½ length of fruit 8
   Pedicels of fruit ½ to 1 x length of fruit 9
   Pedicels of fruit > 1 x length of fruit *Group* 14.

8. Operculum of buds hemispherical 10
   Operculum of buds conical 11

9. Valves deeply enclosed *Group* 12.
   Valves almost exsert *Group* 13.

10. Mature leaves short (up to 12 cms. in length) *Group* 8.
Mature leaves long (> 12 cms. long) *Group* 9.

11. Valves deeply enclosed *Group* 10.
Valves almost exsert *Group* 11.

12. Operculum of buds hemispherical 13
Operculum of buds conical *Group* 17.

13. Mature leaves more than 12 cms. long *Group* 15.
Mature leaves up to 12 cms. long *Group* 16.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

115. *regnans*

GROUP 2.

46. foecunda
67. linearis
89. nitida
117. Risdoni

GROUP 3.

91. *obliqua*
113. *radiata*
129. *Sieberiana*
134. tasmanica (Risdoni var. elata)

GROUP 4.

30. congener
100. *pauciflora* (coriacea)
104. piperita
115. *regnans*

GROUP 5.

9. Andrewsi
91. *obliqua*
113. *radiata*
129. *Sieberiana*

GROUP 6.

104. piperita

GROUP 7.

140. transcontinentalis

GROUP 8.

48. gamophylla
67. linearis
89. nitida
117. Risdoni
132. stricta

GROUP 9.

39. dives
91. *obliqua*
113. *radiata*
134. tasmanica (Risdoni var. elata)
147. vitrea

GROUP 10.

30. congener
47. fraxinoides
100. *pauciflora* (coriacea)
132. stricta
147. vitrea

GROUP 11.

100. *pauciflora* (coriacea)
126. *scabra* (eugenioides)

GROUP 12.

16. *Bosistoana*
66. *Lindleyana* (numerosa)
80. MELLIODORA
91. *obliqua*
113. *radiata*

GROUP 13.

80. MELLIODORA
113. *radiata*
140. transcontinentalis

GROUP 14.

66. *Lindleyana* (numerosa)

GROUP 15.

63. laevopinea
81. micrantha
113. *radiata*
134. tasmanica (Risdoni var. elata)
147. vitrea

GROUP 16.

81. micrantha
117. Risdoni
134. tasmanica (Risdoni var. elata)

GROUP 17.

47. fraxinoides
81. micrantha
126. *scabra* (eugenioides)
147. vitrea

SECTION XXIV.

Inflorescence axillary; umbels multi-flowered; peduncle of fruits terete; fruit pedicellate; peduncle short (up to 1 cm. long); valves enclosed; fruit medium (longest axis 0.6 to 1.0 cms); venation of mature leaves oblique or transverse.

KEY TO THE GROUPS.

1. Venation of mature leaves oblique 2
Venation of mature leaves transverse *Group* 12.

2. Fruit longer than broad 3
   Fruit as long as broad 6
   Fruit broader than long *Group* 11.

3. Pedicels of fruit up to ½ length of fruit 4
   Pedicels of fruit ½ to 1 x length of fruit 5
   Pedicels of fruit > 1 x length of fruit *Group* 5.

4. Operculum of buds hemispherical *Group* 1.
   Operculum of buds conical or rostrate *Group* 2.

5. Operculum of buds conical *Group* 3.
   Operculum of buds rostrate *Group* 4.

6. Pedicels of fruit up to ½ length of fruit 7
   Pedicels of fruit > ½ length of fruit 8

7. Mature leaves up to 12 cms. long *Group* 6.
   Mature leaves more than 12 cms. long *Group* 7.

8. Operculum of buds hemispherical *Group* 8.
   Operculum of buds conical or rostrate 9

9. Mature leaves up to 12 cms. long *Group* 9.
   Mature leaves more than 12 cms. long *Group* 10.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

106. POLYANTHEMOS

GROUP 2.

58. hemiphloia
94. odorata
95. oleosa
104. piperita

GROUP 3.

79. melanophloia
94. odorata
95. oleosa
104. piperita

GROUP 4.

95. oleosa
140. transcontinentalis

GROUP 5.

94. odorata
128. SIDEROXYLON

GROUP 6.

61. jugalis
94. odorata
95. oleosa
97. *ovata*

GROUP 7.

99. patens
126. *scabra* (eugenioides)

GROUP 8.

66. *Lindleyana* (numerosa)
97. *ovata*

GROUP 9.

94. odorata
95. oleosa
128. SIDEROXYLON
97. *ovata*
140. transcontinentalis

GROUP 10.

16. *Bosistoana*
80. MELLIODORA
140. transcontinentalis

GROUP 11.

63. laevopinea
81. micrantha
97. *ovata*
126. *scabra* (eugenioides)

GROUP 12.

17. *botryoides*
29. Cloeziana
83. MICROCORYS
99. patens

SECTION XXV.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit terete; fruit pedicellate; peduncle short (< 1 cm. long); valves enclosed; fruit small (longest axis not exceeding 0.6 cms); venation of mature leaves longitudinal.

KEY TO THE GROUPS.

1. Fruit longer than broad 2
   Fruit as long as broad 3
   Fruit broader than long ... *Group* 8.

2. Operculum of buds hemispherical *Group* 1.
   Operculum of buds conical *Group* 2.

3. Pedicels of fruit up to ½ length of fruit 4
   Pedicels of fruit more than ½ length of fruit 6

4. Operculum of buds hemispherical *Group* 3.
   Operculum of buds conical 5

5. Valves deeply enclosed *Group* 4.
   Valves almost exsert *Group* 5.

6. Operculum of buds hemispherical *Group* 6.
   Operculum of buds conical *Group* 7.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

9. Andrewsi
31. conica
46. foecunda
67. linearis
113. *radiata*

GROUP 2.

30. congener
31. conica
82. microcarpa
104. piperita

GROUP 3.

31. conica
39. dives
67. linearis
90. nova-anglica
113. *radiata*

GROUP 4.

30. congener
31. conica
118. Robertsoni
131. stellulata

GROUP 5.

90. nova-anglica
118. Robertsoni
149. yarraensis

GROUP 6.

9. Andrewsi
31. conica
66. *Lindleyana* (numerosa)
113. *radiata*

GROUP 7.

31. conica
112. *crebra*
118. Robertsoni
149. yarraensis

GROUP 8.

31. conica
90. nova-anglica
113. *radiata*
122. *salicifolia* (amygdalina)
131. stellulata

SECTION XXVI.

Inflorescence axillary; umbels multi-flowered; peduncle of fruit compressed; pedicellate; peduncle short (< 1 cm. in length); valves enclosed; fruit small (longest axis not exceeding 0.6 cms.); venation of mature leaves oblique.

KEY TO THE GROUPS.

1. Fruit longer than broad 2
   Fruit as broad as long 4
   Fruit broader than long *Group* 7.

2. Operculum of buds hemispherical *Group* 1.
   Operculum of buds conical 3

3. Mature leaves short and broad (< 12 cms. long x < 2 cms broad)

4. Operculum of buds hemispherical — *Group* 4.
   Operculum of buds conical 5

5. Mature leaves long (> 12 cms. in length) — *Group* 5.
   Mature leaves short (< 12 cms. in length) — *Group* 6.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 4.	Group 6.
31. conica	14. *bicolor*	31. conica
	31. conica	94. odorata
Group 2.	66. *Lindleyana* (numerosa)	97. *ovata*
	90. nova-anglica	149. yarraensis
31. conica	97. *ovata*	
82. microcarpa		Group 7.
	Group 5.	31. conica
Group 3.		90. nova-anglica
	80. MELLIODORA	97. *ovata*
13. Beyeri	90. nova-anglica	
31. conica	97. *ovata*	
94. odorata	118. Robertsoni	
102. pilligaensis		

SECTION XXVII.

Inflorescence axillary; umbels multi-flowered; peduncle of fruit compressed; fruit sessile.

KEY TO THE GROUPS.

1. Peduncle of fruits long (> 2 cms. in length) 2
   Peduncle of fruits medium (1-2 cms. in length) 3
   Peduncle of fruits short (< 1 cm. in length) 6

2. Valves exsert — *Group* 1.
   Valves enclosed — *Group* 2.

3. Valves exsert 4
   Valves enclosed 5

4. Valves strongly exsert — *Group* 3.
   Valves slightly exsert — *Group* 4.

5. Valves deeply enclosed — *Group* 5.
   Valves almost exsert — *Group* 6.

6. Valves exsert 7
   Valves enclosed 11

7. Venation of mature leaves longitudinal — *Group* 7.
   Venation of mature leaves oblique 8
   Venation of mature leaves transverse — *Group* 12.

8. Fruit medium (longest axis 0.6 to 1.0 cms.) 9
   Fruit small (longest axis not exceeding 0.6 cms.). 10

9. Valves strongly exsert — *Group* 8.
   Valves slightly exsert — *Group* 9.

10. Valves strongly exsert — *Group* 10.
    Valves slightly exsert — *Group* 11.

11. Venation of mature leaves longitudinal 12
Venation of mature leaves oblique *Group* 15.
Venation of mature leaves transverse *Group* 16.

12. Mature leaves more than 12 cms. in length *Group* 13.
Mature leaves up to 12 cms. in length *Group* 14.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

24. capitellata
51. *gomphocephala*
64. LEHMANNI

GROUP 2.

24. capitellata

GROUP 3.

18. BRIDGESIANA
70. *Macarthuri*
75. MAIDENI
123. *saligna*
125A. salubris var. glauca

GROUP 4.

24. capitellata
25. *cephalocarpa* (cinerea var. multiflora)
40. elaeophora
123. *saligna*
126. *scabra* (eugenioides)

GROUP 5.

6. *albens*
17. *botryoides*
40. elaeophora
91. *obliqua*

GROUP 6.

3. agglomerata
24. capitellata
40. elaeophora
123. *saligna*
126. *scabra* (eugenioides)

GROUP 7.

24. capitellata
25. *cephalocarpa* (cinerea var. multiflora)
40. elaeophora
88. nitens
126. *scabra* (eugenioides)

GROUP 8.

18. BRIDGESIANA
75. MAIDENI
125A. salubris var. glauca

GROUP 9.

25. *cephalocarpa* (cinerea var. multiflora)
40. elaeophora
97. *ovata*
126. *scabra* (eugenioides)

GROUP 10.

18. BRIDGESIANA
70. *Macarthuri*
111. quadrangulata
125A. salubris var. glauca

GROUP 11.

25. *cephalocarpa* (cinerea var. multiflora)
97. *ovata*

GROUP 12.

123. *saligna*

GROUP 13.

24. capitellata
40. elaeophora
88. nitens
91. *obliqua*
126. *scabra* (eugenioides)

GROUP 14.

67. linearis

GROUP 15.

3. agglomerata
33. cosmophylla
40. elaeophora
97. *ovata*
126. *scabra* (eugenioides)

GROUP 16.

17. *botryoides*
33. cosmophylla
123. *saligna*

SECTION XXVIII.

Inflorescence axillary; umbels multi-flowered; peduncle of fruits compressed; fruit pedicellate; peduncle long (> 2 cms. in length).

KEY TO THE GROUPS.

1. Valves exsert 2
Valves enclosed 4

2. Venation of mature leaves longitudinal *Group* 1.
Venation of mature leaves oblique *Group* 2.
Venation of mature leaves transverse 3

3.	Fruit large (longest axis exceeding 1.0 cms.)	*Group* 3.
	Fruit medium or small (longest axis up to 1.0 cms.)	*Group* 4.
4.	Venation of mature leaves longitudinal	*Group* 5.
	Venation of mature leaves oblique	*Group* 6.
	Venation of mature leaves transverse	*Group* 7.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 3.	Group 5.
93. *occidentalis*	55. grandis var. grandiflora	96. *oreades* (altior)
96. *oreades* (altior)	62. *Kirtoniana*	146. virgata (Leuhmanniana)
105. platypus	86. ROBUSTA	
	101. pellita	
Group 2.		**Group 6.**
5. alba	**Group 4.**	146. virgata (Leuhmanniana)
62. *Kirtoniana*		
75. MAIDENI	54. GRANDIS	
93. *occidentalis*	55. grandis var. grandiflora	**Group 7.**
	62. *Kirtoniana*	
	116. RESINIFERA	38. DIVISERSICOLOR
		69A. *longifolia var. multiflora*
		77. marginata
		86. ROBUSTA

SECTION XXIX.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit compressed; fruit pedicellate; peduncle medium (1-2 cms. long); fruit large (longest axis exceeds 1.0 cms); valves exsert.

KEY TO THE GROUPS.

1.	Venation of mature leaves longitudinal or oblique	2
	Venation of mature leaves transverse	*Group* 3.
2.	Valves strongly exsert	*Group* 1.
	Valves slightly exsert	*Group* 2.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 2.	Group 3.
23. canaliculata	85. *Muelleriana*	23. canaliculata
62. *Kirtoniana*	93. *occidentalis*	55. grandis var. grandiflora
75. MAIDENI		62. *Kirtoniana*
105. platypus		101. pellita
110. *punctata*		110. *punctata*

SECTION XXX.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit compressed; fruit pedicellate; peduncle medium (1-2 cms. long); fruit medium (longest axis 0.6 to 1.0 cms); valves exsert; venation of mature leaves longitudinal or transverse.

KEY TO THE GROUPS.

1.	Venation of mature leaves longitudinal		2
	Venation of mature leaves transverse		4
2.	Valves strongly exsert	*Group*	1.
	Valves slightly exsert		3
3.	Pedicels of fruits up to ½ length of fruit	*Group*	2.
	Pedicels of fruit more than ½ length of fruit	*Group*	3.
4.	Operculum of buds hemispherical	*Group*	4.
	Operculum of buds conical	*Group*	5.
	Operculum of buds rostrate	*Group*	6.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

125. *salubris*
130. *Smithii*
140. transcontinentalis

GROUP 2.

25. *cephalocarpa* (cinerea var. multiflora)
39. dives
63. laevopinea
96. *orcades* (altior)
126. *scabra* (eugenioides)

GROUP 3.

9. Andrewsi

GROUP 4.

54. GRANDIS
55. grandis var. grandiflora
83. MICROCORYS
108. propinqua
123. *saligna*

GROUP 5.

55. grandis var. grandiflora
108. propinqua
116. RESINIFERA
123. *saligna*

GROUP 6.

54. GRANDIS
55. grandis var. grandiflora
62. *Kirtoniana*
116. RESINIFERA
123. *saligna*

SECTION XXXI.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit compressed; fruit pedicellate; peduncle medium (1-2 cms. long); fruit medium (longest axis 0.6 to 1.0 cms.); valves exsert; venation of mature leaves oblique.

KEY TO THE GROUPS.

1.	Fruit longer than broad		2
	Fruit as long as broad		5
	Fruit broader than long		11
2.	Pedicels of fruit up to ½ length of fruit		3
	Pedicels of fruit more than ½ length of fruit		4
3.	Mature leaves more than 12 cms. long	*Group*	1.
	Mature leaves up to 12 cms. long	*Group*	2.
4.	Mature leaves more than 12 cms. long	*Group*	3.
	Mature leaves up to 12 cms. long	*Group*	4.
5.	Pedicels of fruit up to ½ length of fruit		6
	Pedicels of fruit more than ½ length of fruit		7
6.	Valves strongly exsert	*Group*	5.
	Valves slightly exsert	*Group*	6.
7.	Operculum of buds hemispherical or conical		8
	Operculum of buds rostrate		10

8. Valves strongly exsert 9
   Valves slightly exsert *Group* 9.

9. Mature leaves more than 12 cms. long *Group* 7.
   Mature leaves up to 12 cms. long *Group* 8.

10. Mature leaves more than 12 cms. long *Group* 10.
    Mature leaves up to 12 cms. long *Group* 11.

11. Pedicels of fruit up to ½ length of fruit 12
    Pedicels of fruit more than ½ length of fruit 13

12. Valves strongly exsert *Group* 12.
    Valves slightly exsert *Group* 13.

13. Operculum of buds as long as or shorter than calyx tube *Group* 14.
    Operculum of buds longer than calyx tube *Group* 15.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

25. *cephalocarpa* (cinerea var. multiflora)
53. *goniocalyx*
93. *occidentalis*
110. *punctata*

GROUP 2.

25. *cephalocarpa* (cinerea var. multiflora)
93. *occidentalis*
95. oleosa
148. Wandoo

GROUP 3.

15. Blakelyi
53. *goniocalyx*
62. *Kirtoniana*
110. *punctata*
140. transcontinentalis

GROUP 4.

10. astringens
95. oleosa
140. transcontinentalis

GROUP 5.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
75. MAIDENI
95. oleosa
110. *punctata*

GROUP 6.

25. *cephalocarpa* (cinerea var. multiflora)
53. *goniocalyx*
63A. laevopinea var. minor
126. *scabra* (eugenioides)

GROUP 7.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
75. MAIDENI
110. *punctata*
130. *Smithii*

GROUP 8.

95. oleosa

GROUP 9.

5. alba
53. *goniocalyx*
143. umbra

GROUP 10.

5. alba
15. Blakelyi
110. *punctata*
140. transcontinentalis
143. umbra

GROUP 11.

5. alba
10. astringens
95. oleosa
140. transcontinentalis
143. umbra

GROUP 12.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
110. *punctata*
125. *salubris*

GROUP 13.

63A. laevopinea var. minor
85. *Muelleriana*
126. *scabra* (eugenioides)

GROUP 14.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
85. *Muelleriana*
110. *punctata*
130. *Smithii*

GROUP 15.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
110. *punctata*
125. *salubris*
143. umbra

SECTION XXXII.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit compressed; fruit pedicellate; peduncle medium (1-2 cms. long); valves exsert; fruit small (longest axis not exceeding 0.6 cms.).

KEY TO THE GROUPS.

1. Venation of mature leaves longitudinal or oblique 2
   Venation of mature leaves transverse *Group* 4.

2. Valves strongly exsert 3
   Valves slightly exsert *Group* 3.

3. Mature leaves more than 12 cms. long *Group* 1.
   Mature leaves up to 12 cms. long *Group* 2.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 2.	Group 4.
15. Blakelyi	70. *Macarthuri*	15. Blakelyi
18. BRIDGESIANA	125. *salubris*	36. Deanei
43. exserta		108. propinqua
59. HUBERIANA (multi-flowered viminalis)	Group 3.	116. RESINIFERA
70. *Macarthuri*	9. Andrewsi	
	25. *cephalocarpa* (cinerea var. multiflora)	
	39. dives	

SECTION XXXIII.

Inflorescence axillary; umbels multi-flowered; peduncle of fruit compressed; fruit pedicellate; peduncle medium (1-2 cms. long); valves enclosed.

KEY TO THE GROUPS.

1. Fruit large (longest axis > 1 cm. long) 2
   Fruit medium (longest axis 0.6 to 1.0 cms.) 5
   Fruit small (longest axis up to 0.6 cms) 14

2. Venation of mature leaves oblique or longitudinal 3
   Venation of mature leaves transverse *Group* 4.

3. Mature leaves up to 12 cms. long *Group* 1.
   Mature leaves more than 12 cms. long 4

4. Valves deeply enclosed *Group* 2.
   Valves almost exsert *Group* 3.

5. Venation of mature leaves longitudinal 6
   Venation of mature leaves oblique 11

6. Operculum of buds hemispherical 7
   Operculum of buds conical 9

7. Valves deeply enclosed 8
   Valves almost exsert *Group* 7.

8. Mature leaves more than 12 cms. long *Group* 5.
   Mature leaves up to 12 cms. long *Group* 6.

9.	Valves deeply enclosed	10
	Valves almost exsert	*Group* 10.
10.	Mature leaves more than 12 cms. long	*Group* 8.
	Mature leaves up to 12 cms. long	*Group* 9.
11.	Fruit longer than broad	13
	Fruit as broad as long	12
	Fruit broader than long	*Group* 15.
12.	Valves almost exsert	*Group* 13.
	Valves deeply enclosed	*Group* 14.
13.	Operculum of buds hemispherical or conical	*Group* 11.
	Operculum of buds rostrate	*Group* 12.
14.	Valves almost exsert	*Group* 16.
	Valves deeply enclosed	*Group* 17.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

92. obtusiflora
114. reduncа
144. urnigera

GROUP 2.

6. *albens*
103. PILULARIS
129. *Sieberiana*
137. Todtiana
144. urnigera

GROUP 3.

85. *Muelleriana*

GROUP 4.

38. DIVERSICOLOR
77. marginata

GROUP 5.

91. *obliqua*
100. *pauciflora* (coriacea)
129. *Sieberiana*
147. vitrea

GROUP 6.

46. foecunda
100. *pauciflora* (coriacea)
132. stricta

GROUP 7.

9. Andrewsi
39. dives
57. haemastoma
100. *pauciflora* (coriacea)
117. Risdoni

GROUP 8.

6. *albens*
30. congener
47. fraxinoides
100. *pauciflora* (coriacea)
147. vitrea

GROUP 9.

2. affinis
100. *pauciflora* (coriacea)
132. stricta

GROUP 10.

96. *oreades* (altior)
100. *pauciflora* (coriacea)
126. *scabra* (eugenioides)
140. transcontinentalis

GROUP 11.

53. *goniocalyx*
91. *obliqua*
96. *oreades* (altior)
141. triantha (acmenioides)
148. Wandoo (reduncа var. elata)

GROUP 12.

114. reduncа
140. transcontinentalis
141. triantha (acmenioides)
148. Wandoo (reduncа var. elata)

GROUP 13.

53. *goniocalyx*
96. *oreades* (altior)
126. *scabra* (eugenioides)
141. triantha (acmenioides)
143. umbra

GROUP 14.

91. *obliqua*

GROUP 15.

85. *Muelleriana*
126. *scabra* (eugenioides)
143. umbra

GROUP 16.

9. Andrewsi
36. Deanei
39. dives
57. haemastoma
141. triantha (acmenioides)

GROUP 17.

30. congener
46. foecunda
104. piperita

SECTION XXXIV.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit compressed; fruit pedicellate; peduncles short (up to 1 cm. long); valves exsert.

KEY TO THE GROUPS.

1.	Fruit large (longest axis exceeds 1.0 cms.)	*Group* 1.
	Fruit medium (longest axis 0.6 to 1.0 cms.)	2
	Fruit small (longest axis up to 0.6 cms.)	11
2.	Venation of mature leaves longitudinal or oblique	3
	Venation of mature leaves transverse	*Group* 12.
3.	Fruit longer than broad	4
	Fruit as long as broad	5
	Fruit broader than long	10
4.	Valves slightly exsert	*Group* 2.
	Valves strongly exsert	*Group* 3.
5.	Pedicels of fruits up to ½ length of fruit	8
	Pedicels of fruits more than ½ length of fruit	6
6.	Valves strongly exsert	7
	Valves slightly exsert	*Group* 9.
7.	Mature leaves more than 12 cms. long	*Group* 7.
	Mature leaves up to 12 cms. long	*Group* 8.
8.	Mature leaves usually shorter than 12 cms.	*Group* 4.
	Mature leaves longer than 12 cms.	9
9.	Valves strongly exsert	*Group* 5.
	Valves slightly exsert	*Group* 6.
10.	Mature leaves usually shorter than 12 cms.	*Group* 10.
	Mature leaves longer than 12 cms.	*Group* 11.
11.	Venation of mature leaves longitudinal or oblique	12
	Venation of mature leaves transverse	*Group* 19.
12.	Fruit longer than broad	*Group* 13.
	Fruit as long as broad	13
	Fruit broader than long	*Group* 18.
13.	Pedicels of fruits up to ½ length of fruit	14
	Pedicels of fruits more than ½ length of fruit	15
14.	Mature leaves more than 12 cms. long	*Group* 14.
	Mature leaves up to 12 cms. long	*Group* 15.
15.	Mature leaves more than 12 cms. long	*Group* 16.
	Mature leaves up to 12 cms. long	*Group* 17.

THE REPRESENTATIVES OF THE GROUPS.

Group 1.	Group 2.	Group 3.
23. canaliculata	9. Andrewsi	95. oleosa
75. MAIDENI	25. *cephalocarpa* (cinerea var. multiflora)	110. *punctata*
101. pellita	53. *goniocalyx*	140. transcontinentalis
110. *punctata*	96. *oreades* (altior)	
	148. Wandoo (redunca var. elata)	

GROUP 4.

39. dives
95. oleosa
97. *ovata*

GROUP 5.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
75. MAIDENI
110. *punctata*

GROUP 6.

39. dives
53. *goniocalyx*
96. *oreades* (altior)
126. *scabra* (eugenioides)

GROUP 7.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
140. transcontinentalis
110. *punctata*
130. *Smithii*

GROUP 8.

95. oleosa
140. transcontinentalis

GROUP 9.

9. Andrewsi
53. *goniocalyx*
97. *ovata*

GROUP 10.

97. *ovata*
125. *salubris*

GROUP 11.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
110. *punctata*
126. *scabra* (eugenioides)
130. *Smithii*

GROUP 12.

54. GRANDIS
83. MICROCORYS
108. propinqua
116. RESINIFERA
123. *saligna*

GROUP 13.

9. Andrewsi
25. *cephalocarpa* (cinerea var. multiflora)
111. quadrangulata

GROUP 14.

18. BRIDGESIANA
39. dives
59. HUBERIANA (multi-flowered viminalis)
70. *Macarthuri*

GROUP 15.

39. dives
70. *Macarthuri*
97. *ovata*
149. yarraensis

GROUP 16.

9. Andrewsi
18. BRIDGESIANA
43. exserta
59. HUBERIANA (multi-flowered viminalis)

GROUP 17.

9. Andrewsi
97. *ovata*
149. yarraensis

GROUP 18.

18. BRIDGESIANA
59. HUBERIANA (multi-flowered viminalis)
70. *Macarthuri*
97. *ovata*
125. *salubris*

GROUP 19.

108. propinqua
116. RESINIFERA

SECTION XXXV.

Inflorescence axillary; umbels multi-flowered; peduncles of fruit compressed; fruit pedicellate; peduncle short (up to 1 cm. long); valves enclosed.

KEY TO THE GROUPS.

1. Fruit large (longest axis exceeds 1.0 cms) 2
   Fruit medium (longest axis 0.6 to 1.0 cms.) 3
   Fruit small (longest axis up to 0.6 cms.) 10

2. Venation of mature leaves longitudinal — *Group* 1.
   Venation of mature leaves oblique — *Group* 2.
   Venation of mature leaves transverse — *Group* 3.

3. Venation of mature leaves longitudinal 4
   Venation of mature leaves oblique 9
   Venation of mature leaves transverse — *Group* 12.

4. Operculum of buds hemispherical 5
   Operculum of buds conical 8

5.	Mature leaves up to 12 cms. long	6
	Mature leaves more than 12 cms. long	7
6.	Valves almost exsert	*Group* 4.
	Valves deeply enclosed	*Group* 5.
7.	Valves almost exsert	*Group* 6.
	Valves deeply enclosed	*Group* 7.
8.	Valves deeply enclosed	*Group* 8.
	Valves almost exsert	*Group* 9.
9.	Mature leaves up to 12 cms. long	*Group* 10.
	Mature leaves more than 12 cms. long	*Group* 11.
10.	Valves almost exsert	*Group* 13.
	Valves deeply enclosed	*Group* 14.

THE REPRESENTATIVES OF THE GROUPS.

GROUP 1.

92. obtusiflora
129. *Sieberiana*

GROUP 2.

103. PILULARIS
114. redunca
137. Todtiana
144. urnigera

GROUP 3.

77. marginata

GROUP 4.

9. Andrewsi
39. dives
67. linearis
100. *pauciflora* (coriacea)

GROUP 5.

46. foecunda
67. linearis
100. *pauciflora* (coriacea)
117. Risdoni
132. stricta

GROUP 6.

9. Andrewsi
39. dives
96. *oreades* (altior)
100. *pauciflora* (coriacea)

GROUP 7.

91. *obliqua*
100. *pauciflora* (coriacea)
129. *Sieberiana*
147. vitrea

GROUP 8.

30. congener
47. fraxinoides
100. *pauciflora* (coriacea)
132. stricta
147. vitrea

GROUP 9.

96. *oreades* (altior)
100. *pauciflora* (coriacea)
126. *scabra* (eugenioides)
140. transcontinentalis

GROUP 10.

94. odorata
95. oleosa
97. *ovata*
114. redunca
148. Wandoo (redunca var. elata)

GROUP 11.

53. *goniocalyx*
126. *scabra* (eugenioides)
140. transcontinentalis

GROUP 12.

17. *botryoides*
83. MICROCORYS
123. *saligna*

GROUP 13.

9. Andrewsi
39. dives
67. linearis
97. *ovata*
149. yarraensis

GROUP 14.

30. congener
46. foecunda
67. linearis
94. odorata
104. piperita

SUMMARY

The key set forth is based on material available in the herbarium of the Division of Forestry, at Pretoria, which undoubtedly contains the most comprehensive collection of Eucalypt specimens in South Africa. The ultimate divisions of the key consist of groups of five or fewer species, differentiation between the members of which is made

possible by reference to drawings and to a schedule. This schedule, in addition to the characteristics used in the key, includes further characteristics, superfluous to the requirements of the key, but useful in the final differentiation. The identification of a very few of the closely related species, which can be satisfactorily undertaken only in the herbarium, is outside the scope of this key. The major divisions of the key are sections, the running down of which involves the examination of mature leaves and fruits alone. Each section is sub-divided into groups, which in the majority of cases are also traceable from the limited amount of material required in running down sections. The identification of the remaining groups necessitates the additional examination of mature buds. In the differentiation of the individual members of the groups it is usually advisable to supplement the above-mentioned material with notes on the type of bark. The characteristics used in the compilation of the key are the following: the type of inflorescence; the number of flowers in, and the length and shape of the peduncle of, the umbel; the attachment, size, and shape of the fruit; the position of the valves and the length of the pedicel of the fruit; the venation and shape of the mature leaf; and the length and shape of the operculum of the bud.

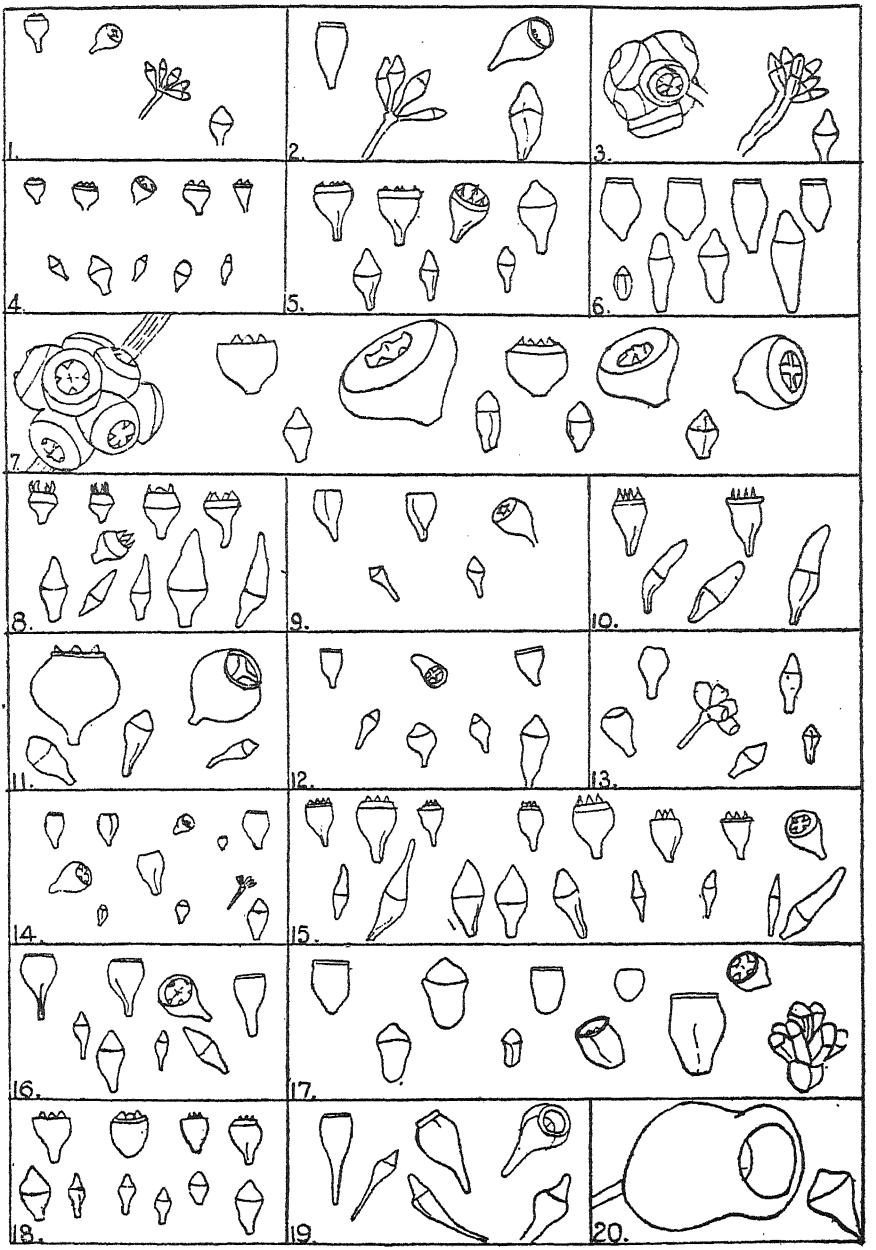


PLATE i.—Figs. 1—20. (Four-fifths actual size)

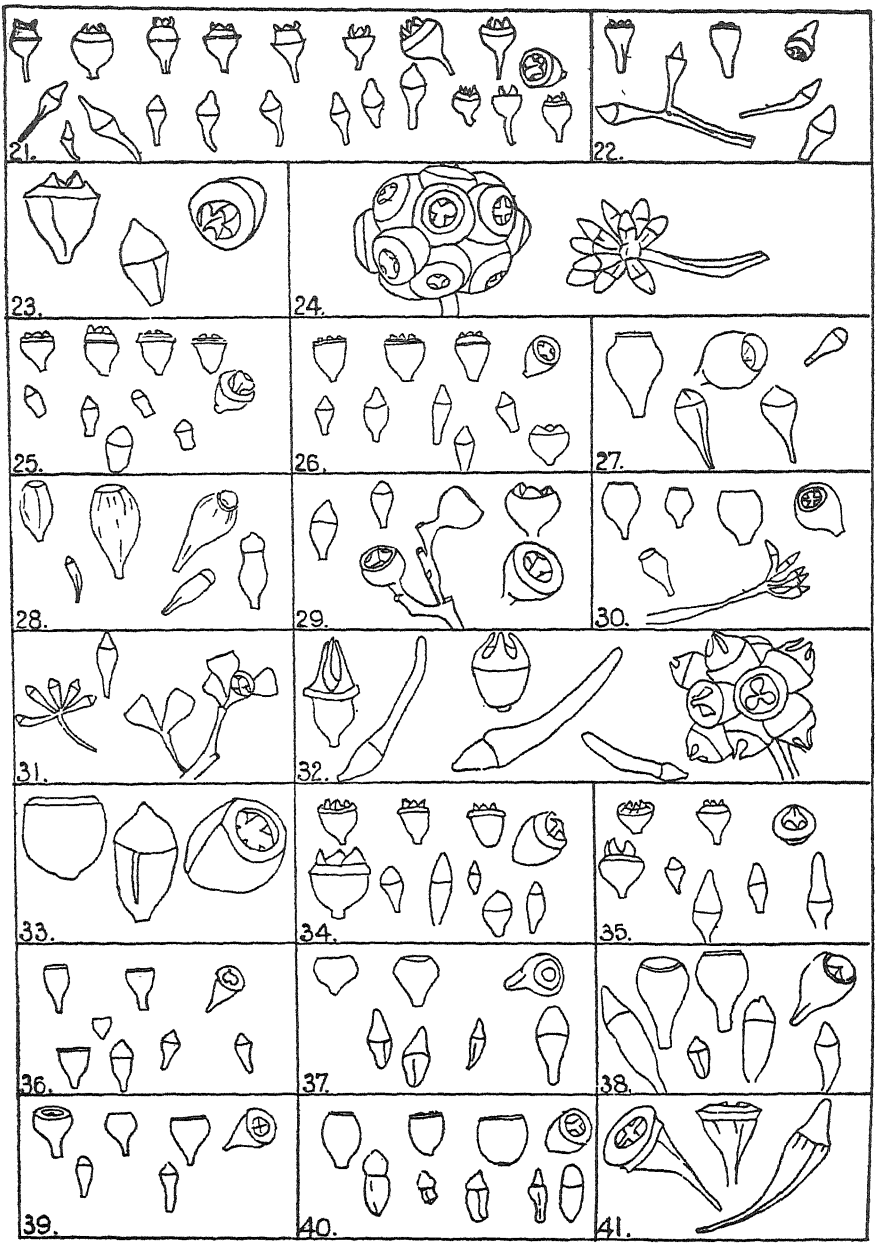


PLATE ii.—Figs. 21—42. (Four-fifths actual size)

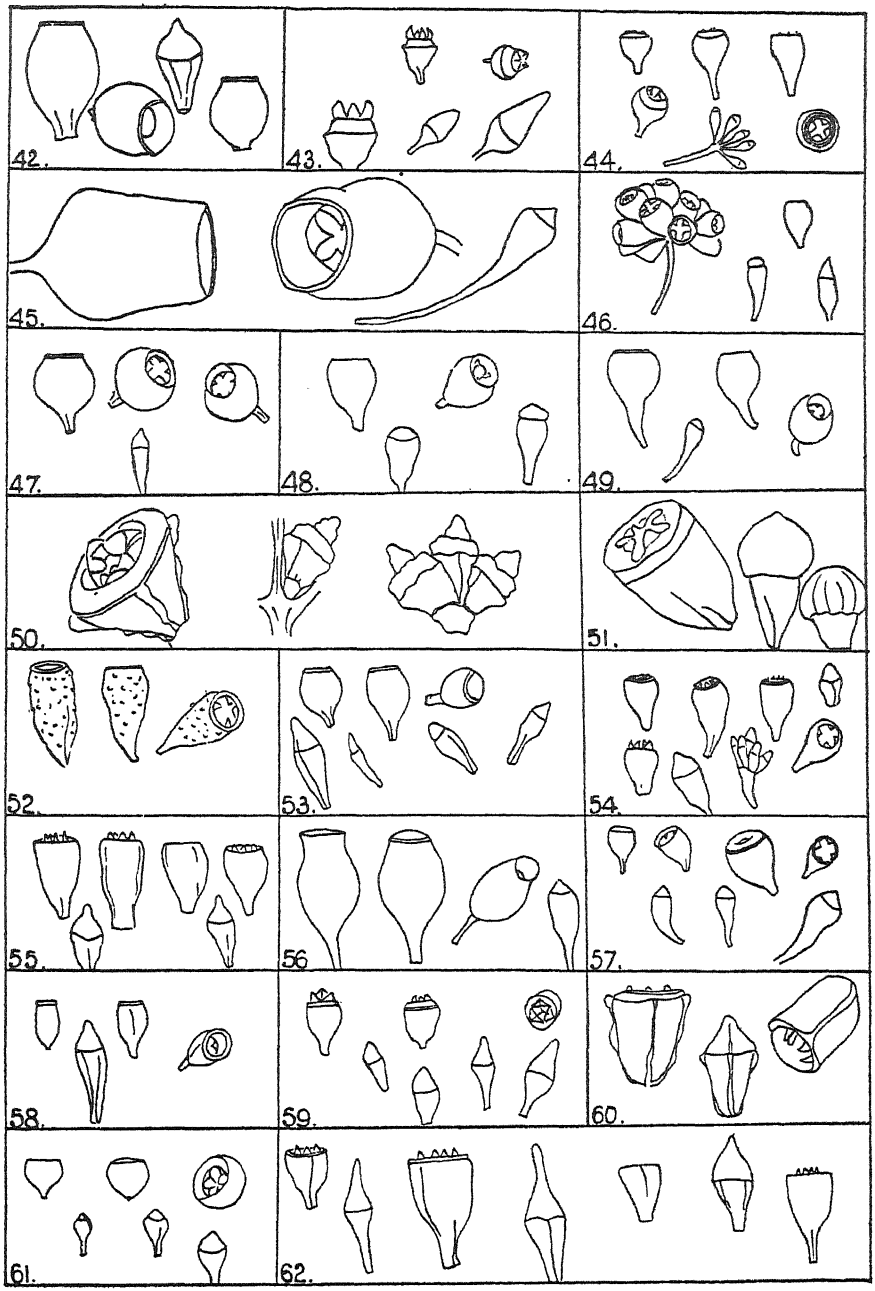


PLATE iii.—Figs. 42—62. (Four-fifths actual size)

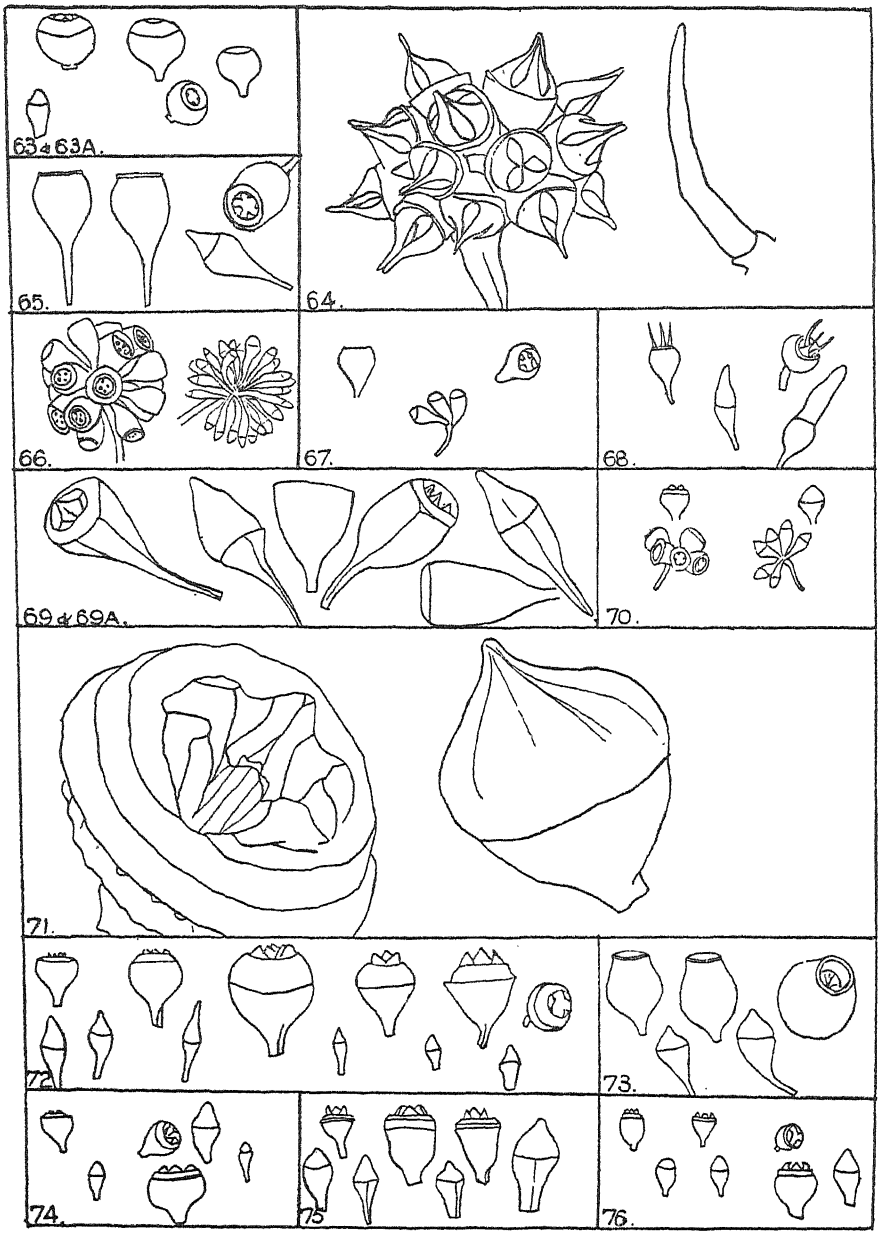


PLATE iv.—Figs. 63—76. (Four-fifths actual size)

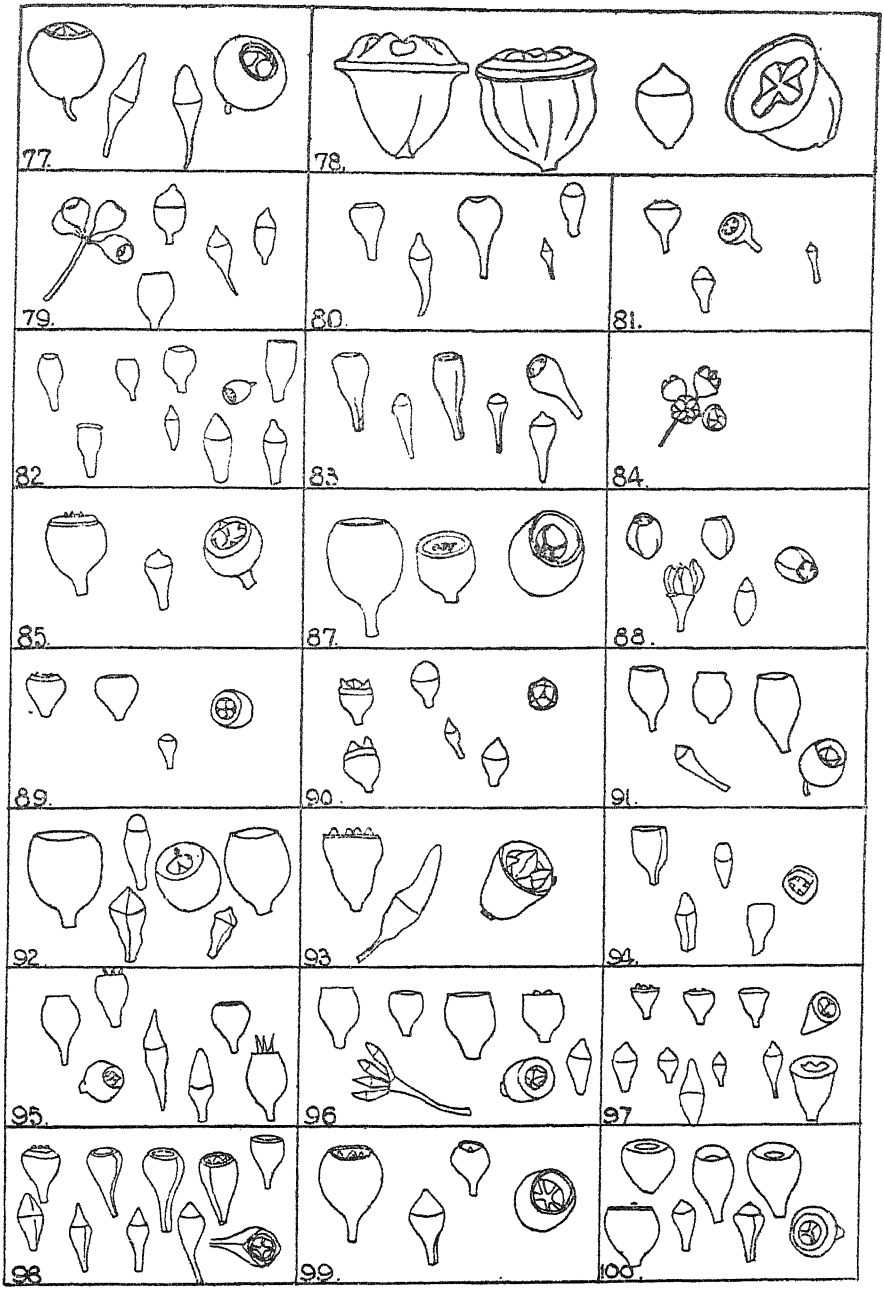


PLATE V.—Figs. 77—100. (Four-fifths actual size)

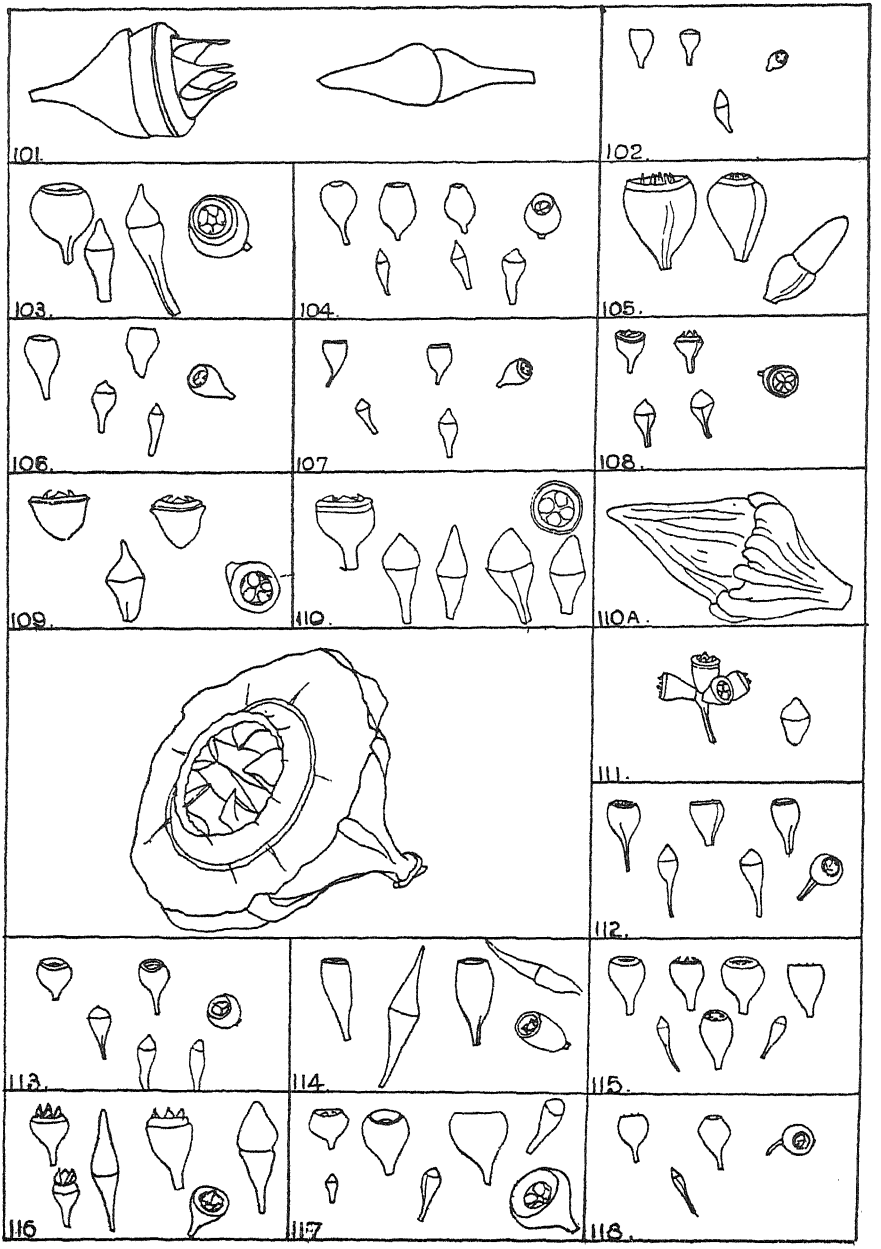


PLATE vi.—Figs. 101—118. (Four-fifths actual size)

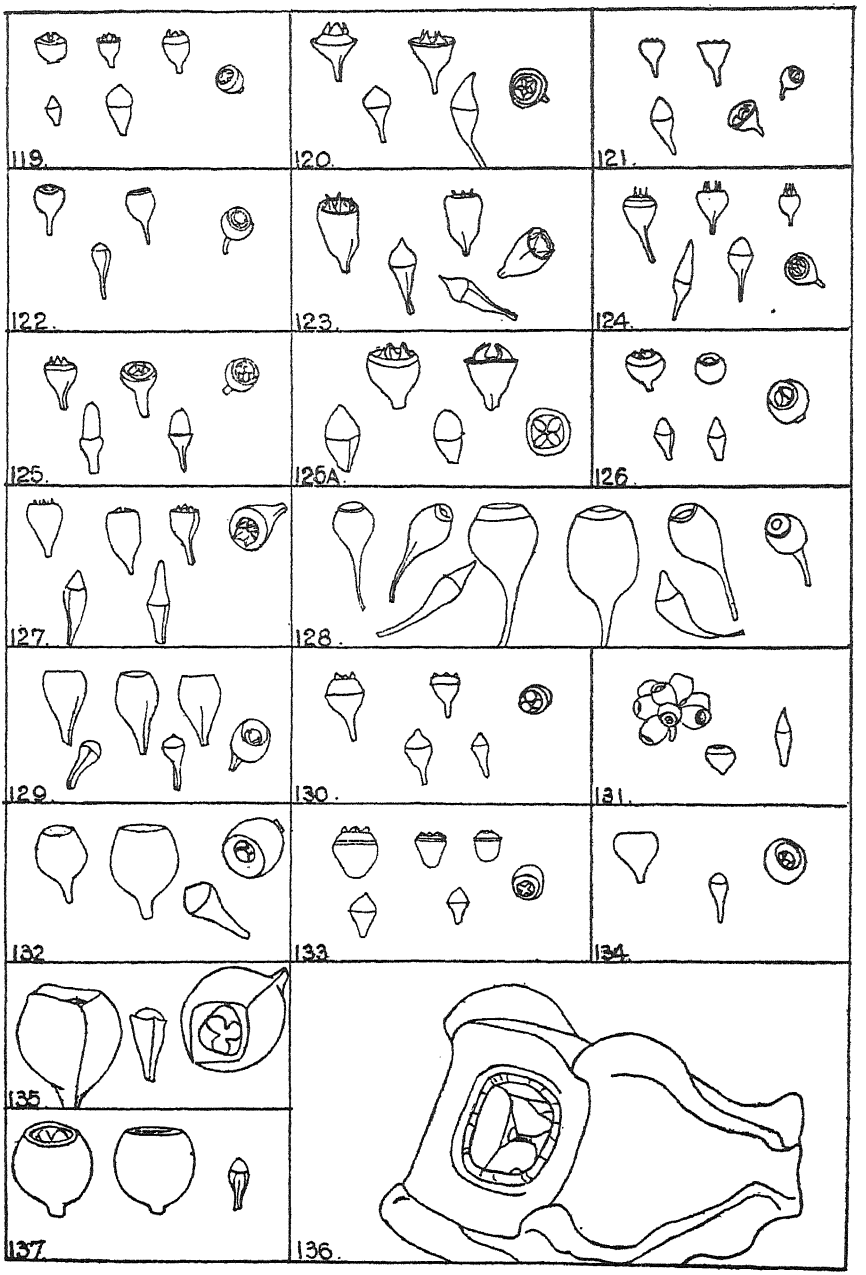


PLATE vii.—Figs. 119—137. (Four-fifths actual size)

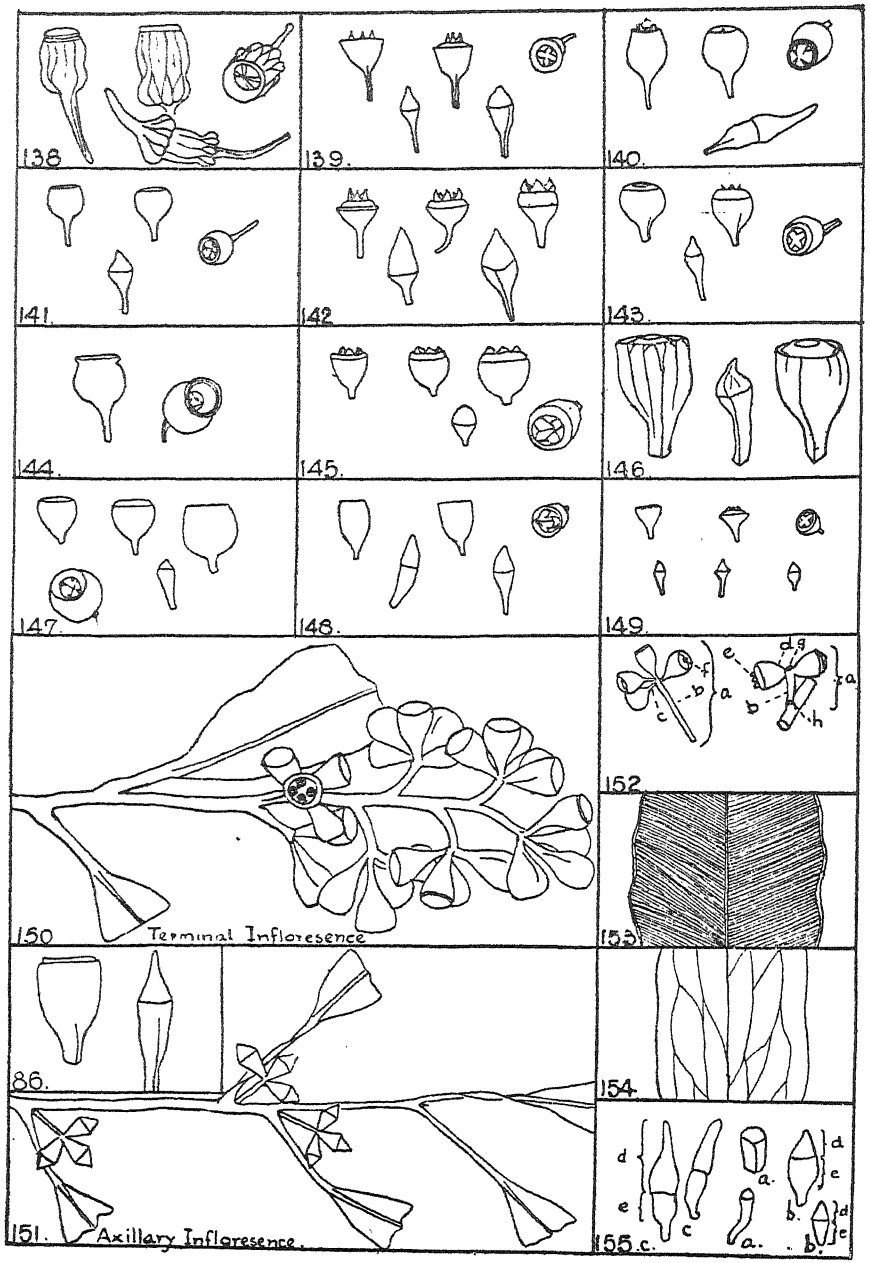


PLATE viii.—Figs. 86 and 138—155. (Four-fifths actual size)

FOREST INFLUENCES RESEARCH TECHNIQUE AT JONKERSHOEK.

By C. L. WICHT.

(Forest Research Officer, Jonkershoek)

Introduction.

THE Jonkershoek Research Station, situated five miles to the south east of Stellenbosch in the winter rainfall region, was established in 1935. The study of technique, the framing of the research programme, and the purchase of standard equipment was subsequently completed, and the first investigations have now been started.

The main object of this research is to determine how normal afforestation, as carried out in State plantations, will affect climate, water conservation and erosion. The aim of such afforestation is the economic production of timber and mainly conifers will be planted for this purpose; yellowwoods and other indigenous trees, as well as broadleaved exotics such as oaks and poplars, are also to be grown on moister sites, however. The afforestation of 3,500 acres, as prescribed in a standard planting plan, will provide the material on which research is to be based.

Observations will determine, quantitatively, the variation in the dispersal of precipitation under different circumstances. The manner in which precipitation is dispersed is determined by climate, topography, geology, soils and plant growth. Of these only the plant growth will be altered directly on a large scale, although, indirectly, this may affect the soil and local climate considerably. The existing flora are to be modified by different experimental treatments such as afforestation, veld-burning, veld-burning with grazing and complete protection. The effects of these treatments on the natural circulation of water will be determined by recording rainfall, evaporation, transpiration, run-off, seepage, streamflow and all natural phenomena which might influence these hydrological processes.

Investigations at Jonkershoek fall into two groups: those which will elucidate the variations in the flow of representative perennial streams, whose catchments will be variously treated, and those which will determine the different hydrological effects of various treatments when they are applied on a uniform experimental site. It is the object of this paper to describe the technique which has been selected and developed for application at Jonkershoek.

The Investigation of Streamflow.

The streamflow from eight catchments which differ considerably in size, topography, soil and local climate, will be recorded. At Emmental in Switzerland (3) and at the Wagon Wheel Gap in California (2), two similar catchments—one afforested and one relatively bare—were selected, and the streamflow from them compared. This will not be

attempted here, as no two catchments in Jonkershoek are even approximately comparable. The records from each stream are to be very carefully analysed; firstly, in order to show how natural differences in the catchments affect the streams, and secondly, to show how the behaviour of the streams is changed by treatment. Each stream is to be studied independently and compared with itself before and after treatment. In each case all factors which might influence streamflow will be observed and correlated. It is hoped that such analyses will disclose general trends common to all catchments. On the basis of these trends it may then be possible to generalise as to the effects of afforestation on streamflow in the winter rainfall region.

The Technique of Gauging Streams.

Seven streamflow recorders are to be erected on tributaries of the Eerste River; the eighth will be on the river itself (see Fig. I). The tributaries are to be gauged over sharp-crested notched weirs. Each stream will be provided with a rectangular V-notch, eighteen inches deep, which will be surmounted, in the case of the larger streams, by a rectangular notch six feet wide and up to two feet six inches deep (see Figs. II and III). The first of these weirs, installed at Bosboukloof was designed by the Irrigation Department.

A stilling pool, the level of which will be recorded automatically on weekly charts, is to be provided above each weir. These records of water level over time, will be converted to flow in cubic feet per second (cusecs) by applying an empirical formula. Formulae for determining the discharge of water through 90°—V-notches have been developed by a number of workers. The general formula, (a) of Figure II, by Barnes (1) is one that has been widely used. Barnes has also extended his formula to apply to compound weirs i.e. weirs where a V-notch and a rectangular notch have been combined. Notched weirs of this form are being used at Jonkershoek (see Figs. II and III), for which formula (b) of Figure II applies.

As this formula is empirical its use for the estimation of the discharge over the Jonkershoek weirs is not justified unless the conditions under which Barnes determined the constants are reproduced exactly. As it was not certain whether this was done, the accuracy of the estimated discharge given by the formula was tested by carrying out experiments on two models of a Jonkershoek weir. One model was quarter size and the other one sixth the size of the original. This work was undertaken by Mr. J. P. Kriel under the direction of Professor A. E. Snape of the Department of Civil Engineering of the University of Cape Town. Kriel (6) has also developed formula (c) of Figure II for use with the Jonkershoek weirs, which applies if the angle of the V-notch is 90 degrees.

Kriel's formula was derived from first principles, the constants having been obtained from the Francis formula (4) for flow over rectangular weirs, and the formula of Thomson (9) for flow over 90° V-notches. This formula was tested at the same time as the one by Barnes.

The experimental results show that both formulae give a fairly exact estimate of discharge. The flows through the V-notch are given more closely by Barnes' formula, however, and the approximation is so accurate that the latter formula has been adopted for use at

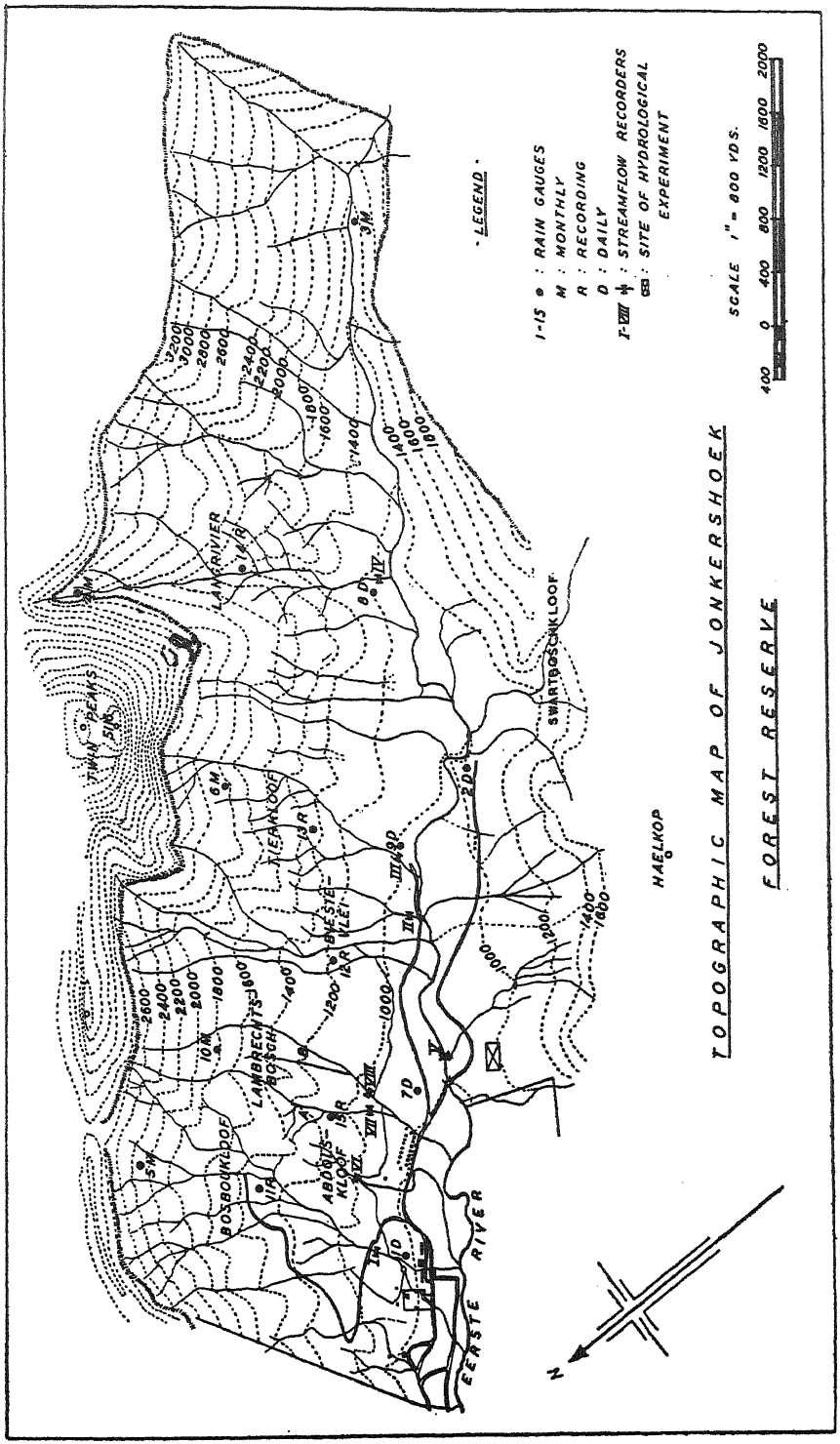
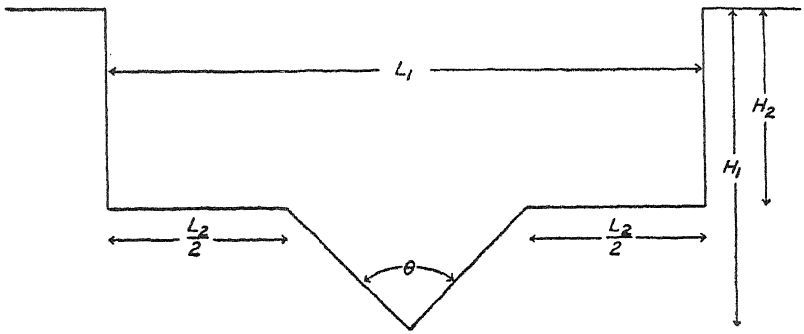


FIG. 1.—Plan of Jonkershoek.



(a) $$Q = 2{\cdot}48\, H_1^{2{\cdot}48}\left\{\frac{\text{TAN}\ \theta/2}{(1/2\ \text{SIN}\ \theta/2)^{\cdot 00703}}\right\}$$

(b) $$Q = 2{\cdot}48\left\{\frac{\text{TAN}\ \theta/2}{(1/2\ \text{SIN}\ \theta/2)^{\cdot 00703}}\right\}\left\{H_1^{2{\cdot}48} - H_2^{2{\cdot}48}\right\} + 3{\cdot}1635\, L_2 H_2^{1{\cdot}49}\left\{\frac{L_2}{L_2 + \frac{H_2}{6}}\right\}^{\cdot 11}$$

(c) $$Q = 2{\cdot}765\left\{H_1^{5/2} - \left\{H_2 + \frac{H_1 - H_2}{9}\right\}^{3/2}\left\{2{\cdot}5\, H_1 - 1{\cdot}5\left(H_2 + \frac{H_1 - H_2}{9}\right)\right\}\right\} +$$
$$3{\cdot}51(L_1 - L_2)\left\{\left(H_2 + \frac{H_1 - H_2}{9}\right)^{3/2} - \left(\frac{H_1 - H_2}{9} + 0{\cdot}14\, H_2\right)^{3/2}\right\} + 3{\cdot}33\, H_2^{3/2}(L_2 - 0{\cdot}2H_2)$$

WHERE Q = DISCHARGE IN CUSECS.

θ = ANGLE OF THE V

H_1 = HEAD OF FLOW OVER APEX OF V-NOTCH IN FEET

H_2 = HEAD OF FLOW OVER RECTANGULAR NOTCH IN FEET

L_1 = WIDTH OF RECTANGULAR NOTCH IN FEET

L_2 = LENGTH OF ACTUAL SILL OF THE RECTANGULAR NOTCH IN FEET

FIG. II.—Sketch of combined V and rectangular notches used at Jonkershoek, with relevant formulae.

Jonkershoek. A closer estimate is not likely to be obtained unless the accuracy with which the head is recorded, and other sources of error, are remedied. There is no doubt that the estimate of streamflow will be sufficiently reliable for the purpose of the investigation. The flows over the rectangular section of the notch are more closely given by Kriel's formula. Neither formula is entirely satisfactory, however, and Mr. Kriel is conducting further investigations in an attempt to develop an improved form.

The estimates of the absolute quantity of water passing over the weirs will be subject to small inaccuracies, but these are not likely to impair the value of the investigation. The relative accuracy of the estimates of discharge will be very high as all the weirs are of the same design and the recorders are sensitive to slight fluctuations in streamflow. It is not expected that the flow of even the largest of these streams will frequently exceed seven cusecs, which is the capacity of the V-notch. The rectangular portion is intended to cope with abnormally high floods.

The gauging of the Eerste River is a more difficult problem, for the flow is estimated to vary from approximately 4 cusecs in the dry season to over 5,000 cusecs after heavy rains. A gauging weir large enough to still the river in flood, would be too costly. The stilling pool would fill up with boulders and silt, and would have to be cleaned frequently. In flood time logs and branches are carried down the river and these would strike against the weir edge and damage it. The bed of the river is, moreover, composed of a mass of loose boulders and it would be impossible to excavate down to a solid rock base. A very deep foundation would, therefore, have to be sunk in order to make the weir-wall safe and to prevent excessive seepage under it after the river had been dammed up. In view of these difficulties the building of a gauging flume of the Venturi type instead of a gauging weir was considered.

Such a flume has a constricted portion or throat, with a gradually narrowing portion leading to the throat and a gradually widening portion leading from it. The flow is gauged by recording the head of the water at one or two places along the flume's length and applying empirical formulae to calculate the actual discharge. The flume as improved by R. L. Parshall (7, 8) may be operated as a single-head device if the water is allowed to run away freely on the downstream side and all banking up of the water is prevented. Because of the narrow section at the throat, the velocity of the water flowing through is relatively higher than the natural flow of the stream, and for this reason any sand or silt in suspension or rolled along the bottom of the channel is carried through, leaving the flume free of deposit. Parshall found that velocity of approach causes very little error in the estimation of discharge by means of such a flume. In general this type of structure seemed to be suitable for the purpose of gauging the Eerste River, but the tremendous fluctuation in flow is a difficulty which cannot be easily overcome. It has been decided, therefore, to gauge only reasonably high floods, but to ensure that low flows are accurately measured. Very high floods occur only once or twice during the winter of every year and they last for only one or two hours. The excessive additional cost of an installation large enough to measure these rare flows accurately was considered to be unwarranted.

The details of the method which has now been adopted, were supplied by Mr. A. M. Sandenberg, the Stellenbosch Town Engineer, who has also directed the building of the flume. The main construction is a fifteen foot Parshall Flume which will gauge flows varying from approximately eight cusecs to 1,000 cusecs (see Figs. IV and V). These flows are calculated from records of the head (H) by the Parshall formula :

$$Q = 4W.H^{1.522W^{0.026}}$$

Here W is the width of the throat of the flume. The exact point at which the head is taken depends on the size of the flume. It is situated along the converging section away from the crest on the upstream side.

Flows lower than fourteen cusecs will be gauged accurately by bolting a temporary barrier in the throat of the flume. This barrier is fitted with a Cippoletti weir notch, three feet long and eighteen inches deep. The notch is trapezoidal in shape, the sides having a slope of 4 in 1. The flow in cusecs is calculated by the formula :

$$Q = 3.367\ LH^{1.5}$$

Here H is the head, L is the length of sill and Q is the discharge.

The recording apparatus will be so placed that it will record the head of water passing through the flume, or—when the barrier is in position—the level of water in the still pool above it. It is expected that this combined method will yield records of the river flow for more than 95 per cent. of the time. In addition, approximate estimates of floods greater than 1,000 cusecs, based on a knowledge of the cross section of the river bed and the velocity of the flowing water, could be made from time to time if required.

Treatments of Catchments.

The natural vegetation throughout Jonkershoek has been extensively modified by veld-burning. The dominant plants in the prevailing associations are shrubs from two to fifteen feet high, according to the site quality and the age of the association since the last burning. The major treatment will be to replace these indigenous shrubby associations by exotic trees. Such afforestation will be applied in four catchments described hereunder. See also Fig. I.

Bosboukloof: A wide basin-like catchment 514 acres in extent, the upper margin of which consists of comparatively low cliffs. Eighty-three per cent. of the area of this catchment will be afforested. Planting and stream gauging were started simultaneously here in 1937 and the area will be completely planted up by 1940.

Biesievlei: This is a small catchment of 80 acres, with gentle slopes and no precipices. Gauging was commenced in 1938, but in order to record the behaviour of the stream prior to afforestation, the vegetation is to remain undisturbed until 1941 when this area will be afforested. As the whole of this catchment is to be afforested it will provide the most complete test of the effect of plantations on streamflow.

Tierkloof: This catchment lies below a large mass of precipices which rise to mountain peaks of 5,000 feet. The altitudinal variation

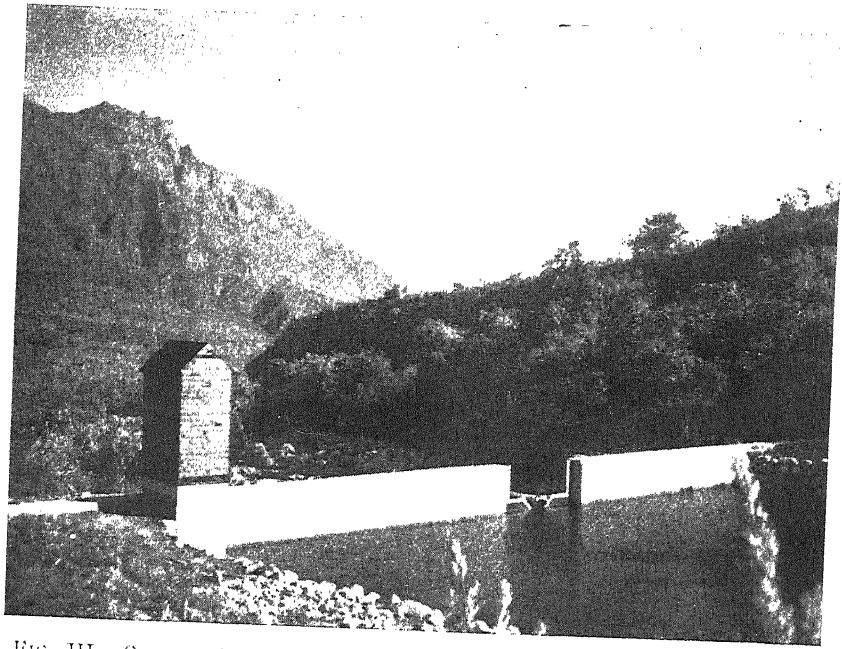


FIG. III.—GAUGING WEIR AT TIERKLOOF. Note hut erected over recorder, and still pool in foreground.

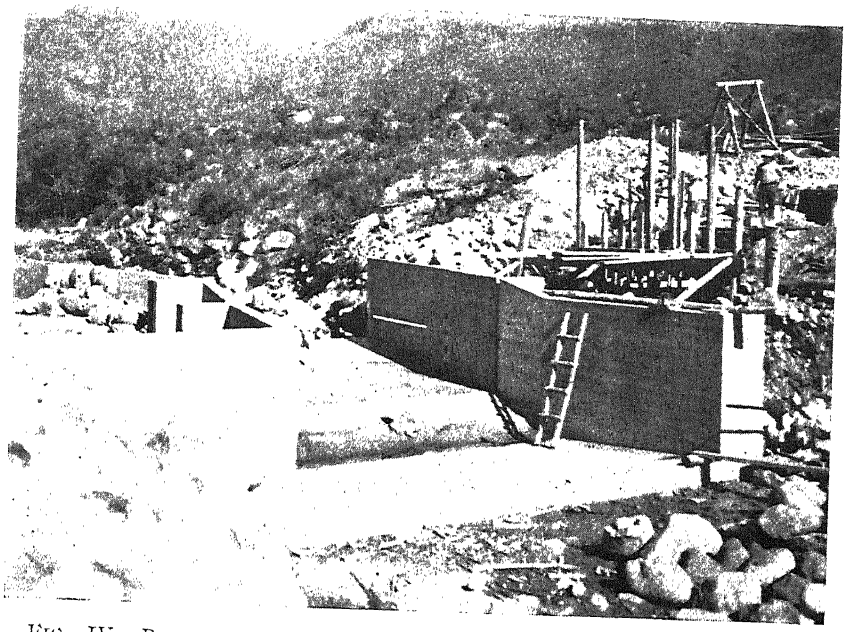


FIG. IV.—PARSHALL FLUME UNDER CONSTRUCTION. Looking upstream.

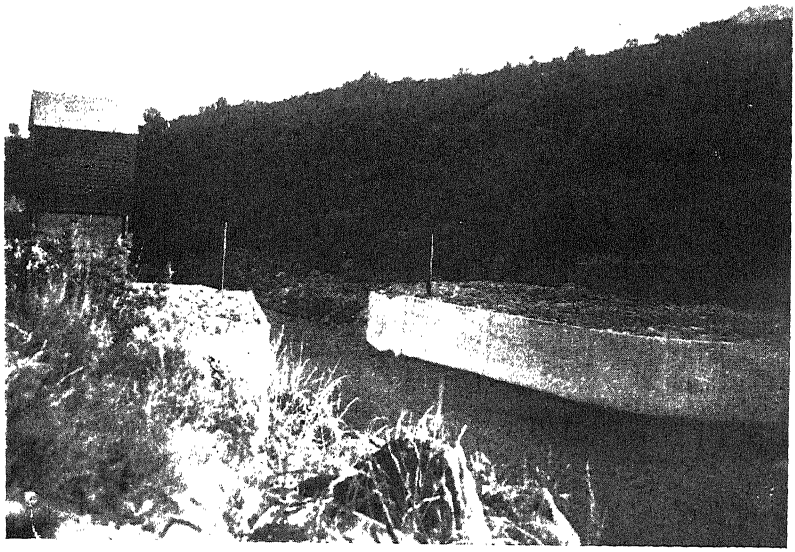


FIG. V.—PARSHALL FLUME COMPLETED. Looking downstream with river at low level.



FIG. VI.—CASELLA SIPHON RAINFALL RECORDER.

within the area is about 4,000 feet, but this is not abnormal for this part of the country. Only the lower slopes, embracing about 50 per cent. of the area, are suitable for afforestation. The exact area of the catchment is not yet known. The low streamflow in summer may be considerably influenced by afforestation because the upper reaches apparently yield very little seepage water and the stream derives almost all the summer flow from the lower slopes. The stream drops to a remarkably low level in dry periods. Gauging was commenced in 1938, but tree-planting will be delayed for twenty-six years. During this period the lower slopes will be burnt on a four year cycle in spring, and reasonable grazing is to be permitted, so as to make a comparison of this treatment with afforestation ultimately possible.

Eerste River: The catchment of the river above the gauging point is about twenty square miles in extent and includes the gauged sub-catchments Biesievlei, Tierkloof and Langrivier. Of this large area only 1,840 acres or about 14 per cent. will be planted up. This afforestation will commence in 1941 but will not be completed before 1965, when the normal afforestation programme will be completed. Gauging will commence in 1939.

The four catchments which have been mentioned will thus be afforested to different degrees. In climate, topography, soil and natural vegetation they are typical of afforestable land in the winter rainfall region.

To provide a strong contrast to afforestation, one catchment—*Abdolskloof*—will be burnt out frequently and grazed heavily by goats. It is expected that this extreme treatment will ultimately lead to complete denudation and severe erosion. This catchment is compact and about 30 acres only in extent.

The next catchment—*Langrivier*—will be protected from fire and all other external influences. The only changes which will occur in this area during the next forty years will be caused by the undisturbed succession of vegetation, and it will be interesting to observe whether this development will affect the behaviour of the stream.

The two remaining catchments are branches of the *Lambrechtsbosch* stream. In the first the natural development of the flora will be encouraged. Tree species, which have been observed to be pioneers at Jonkershoek, such as *Virgilia capensis* Lam., and *Kigellaria afrikana* L., will be planted to pave the way for more valuable indigenous high forest trees. It will thus become possible to find out ultimately in what way the effects of an indigenous forest on water conservation, differ from those of exotic plantations.

In the second *Lambrechtsbosch* catchment the veld is to be burnt in spring on a four year rotation, but no grazing is to be allowed. A low cover of vegetation which is expected to prevent excessive erosion and yet yield the maximum amount of water to streams, will be maintained by this treatment.

The treatments here described have been devised specially to demonstrate the effects of afforestation on streamflow. Other forms of veld management have been included so that their effects may be contrasted with those of afforestation. The investigations will, no doubt, also reveal many new facts relating to the hydrological effects of these subsidiary treatments, however. Such data will be of value to

agriculturists and to civil and irrigation engineers who are interested in the improvement of water supplies.

The Observation of Natural Factors Affecting Streamflow.

Streamflow is affected by a number of natural factors the variations of which must be observed and correlated before the effects of experimental treatments can be isolated.

The behaviour of a stream is affected by the structure and composition of the basic rocks—the geology of the catchment. These directly influence the quantity of water that can be taken up and stored in the area. The geology further affects streamflow indirectly, because it determines the topography of the catchment and to some extent also decides the character of the soil and the vegetation growing on it.

The geology and topography are permanent factors, which will remain unchanged during the course of the investigations. They need be observed only once. A topographic map with 100 feet contours has already been completed for the Jonkershoek area, and a geological map is now being prepared. The soil may be affected by treatment over a long period and repeated studies of the soils of the catchments under investigation are to be undertaken to trace such changes. The vegetation will be modified by treatment, and botanical surveys as well as other intensive vegetational studies will serve to record these modifications.

The factors which have been mentioned affect streamflow because they regulate evaporation and transpiration on the one hand and run-off and seepage on the other. Streamflow is primarily dependent on the quantity of water supplied to the catchment in the form of rainfall, however. Broadly speaking the water in streams may be said to represent the residue of precipitation which has not been evaporated and transpired or held in combination. The quantity held in combination is very small, and may be neglected. Most of the precipitation is returned to the atmosphere and it is unfortunately almost impossible to make any direct estimate of this quantity. Accurate relative measures of evaporation can be obtained, for example, by Livingston-Thone atmometers, and transpiration can also be gauged approximately, but these difficult operations fall within the scope of special studies and cannot easily be maintained for any length of time. A fairly accurate indirect estimate of the water returned to the atmosphere can, however, be obtained because the rainfall and streamflow can be fairly accurately gauged.

The rainfall received by the gauged catchments will be estimated by means of fifteen permanent raingauges (see Fig. I). Five standard 5-inch Snowden gauges, fitted with large containers, have been erected on the inaccessible higher slopes. These accumulate rainfall and are read monthly. A small quantity of liquid paraffin has been introduced into each to provide a protective layer on top of the water to prevent evaporation. Five 8-inch weekly Casella siphon rainfall recorders (see Fig. VI) have also been erected at intermediate levels. These will provide data of intensity and duration of showers, which are to be correlated with the response in streams. At lower levels five ordinary non-recording 5-inch gauges have been placed, which are to be read daily.

Climatic factors like atmospheric humidity, air temperature and wind, will be observed in the course of investigations specially planned to disclose any relation which might exist between their fluctuations and the behaviour of streams.

In a complete investigation of the effects of various treatments on streamflow, the dispersal of all the measured rainfall should be traced. Only then is it possible to explain why a stream responds in a certain way to the treatment applied in its catchment. Treatment disturbs the balanced processes which constitute the water cycle. The regime of the stream reflects only the ultimate effects of this disturbance. In the large scale investigations described above it will not be practical to record the detailed effects of each treatment, without which it is impossible to account for its ultimate effects on the stream; an intensive hydrological research project will, therefore, be established on a uniform site, and it will be attempted to account for the disposal of all precipitation received on this area.

THE INTENSIVE HYDROLOGICAL RESEARCH PROJECT.

The object of this project is to determine how the water relationships on a uniform site are affected by afforestation and other treatments. The experimental site is a smooth, even, mountain slope. The investigation will be carried out in three stages. As the nature of the treatments and the large scale on which they are applied, make the use of statistical methods like replication impossible, exhaustive observations are first to be made to establish whether the site is truly uniform. If so, the treatments will then be applied and observations will be continued thereafter to determine differences in effect. A large number of subsidiary characteristics of the site will also be continually observed.

Description of Treatments and Arrangement of Experiment.

The low shrub vegetation with which the experimental area is now covered will be left undisturbed until 1942. During this period the uniformity of the site will be investigated and possible minor variations evaluated. Three major treatments will then be applied as follows:

1. The south-eastern portion will be afforested with *Pinus insignis* Dougl. (syn. *P. radiata,* D.don.). Within this section a half-acre sample plot will be established wherein all observations will be made. A one-tenth acre run-off plot will be laid out in the centre at about 100 feet from the perimeter of the stand. The sample plot will be re-enumerated each year and the position of all trees and the extent of their crowns will be mapped.

2. Two hundred feet outside the perimeter of the forest a one-tenth acre run-off plot will be established on which the natural vegetation will be permanently protected.

3. A third one-tenth area run-off plot will be laid out six feet from the protected plot and will be burnt in the spring and subjected to moderate grazing with sheep and cows.

Other treatments such as grass planting may be applied on plots adjacent to these, but at present it is not proposed to gauge the run-off from them.

The general arrangement of the experiment is indicated in Fig. VII. The site has a north-eastern aspect (see Fig. I). It has a very uniform slope of 19 degrees 40 minutes and a preliminary examination of the vegetation has disclosed satisfactory uniformity. As the age of

the vegetation was unknown the entire area was burnt off in October, 1938. The soil is granitic but has a strong admixture of silicaceous material from the Table Mountain Sandstone series. The uniformity of the site will be tested further by carrying out as many hydrological observations as possible during the four years prior to afforestation and other treatment.

Technique and Organization of Observations.

1. *Precipitation* :

Water which reaches the earth's surface is dispersed in various ways. A portion is evaporated from plants or from the soil, a portion is transpired, a portion is held in combination by the soil, a portion runs off over the soil surface and the rest seeps away. These processes are to be evaluated quantitatively, and for this purpose it is essential to obtain a reliable estimate of the rainfall. An 8-inch Casella rainfall recorder with daily charts will be used. It will be erected outside the forest, and will indicate the exact time of occurrence, intensity, duration and magnitude of each individual shower.

2. *Rainfall interception* :

A considerable amount of rainfall is caught by the crowns of trees, bushes and other vegetation and evaporated. The moisture thus intercepted will be estimated by the indirect method now to be described.

Precipitation reaches the forest floor by direct penetration through openings in the canopy, by drip from the crowns and by run-off on the tree stems. If the total quantity of water penetrating in these ways is gauged and subtracted from the quantity gauged outside the plantation, the remainder will be an estimate of the total rainfall interception. Direct penetration and drip can be caught by ordinary rain-gauges placed beneath the canopy. The density of the crown cover is normally so variable, however, that a very large number of gauges is required to give a reliable estimate. About twenty gauges in the plantation would most likely give a satisfactory mean (10), but the cost of purchasing so many instruments is high, and the labour required to read them every day, would be considerable. It has, therefore, been decided to use only four standard 5-inch gauges of the Snowden type, but these will not be permanently erected in the usual manner at fixed points. Twenty gauging sites will be selected, and the gauges will be so erected that it will be possible to move them from site to site with ease. The gauges will be placed at sites Nos. 1, 6, 11 and 16 (see Fig. VII) when the observations are commenced. Each one will then be moved to the following site on the next day, so that they will be on sites 2, 7, 12 and 17 on the second day, on 3, 8, 13 and 18 on the third, etc. In this manner the penetration under twenty variations in the canopy will ultimately be sampled, although only four gauges will be employed. For purposes of comparison a similar set of portable gauges will be maintained outside the plantation.

In an exact hydrological investigation the errors in the rainfall records due to differences in the exposure of rain gauges to wind must be eliminated as far as possible. According to Zon (11), Hellman (5) found that an ordinary rain gauge may register 19 per cent. less rainfall than actually falls in a wind of medium velocity. In the experiment described here the differences in exposure between gauges inside and outside the plantation could therefore cause considerable

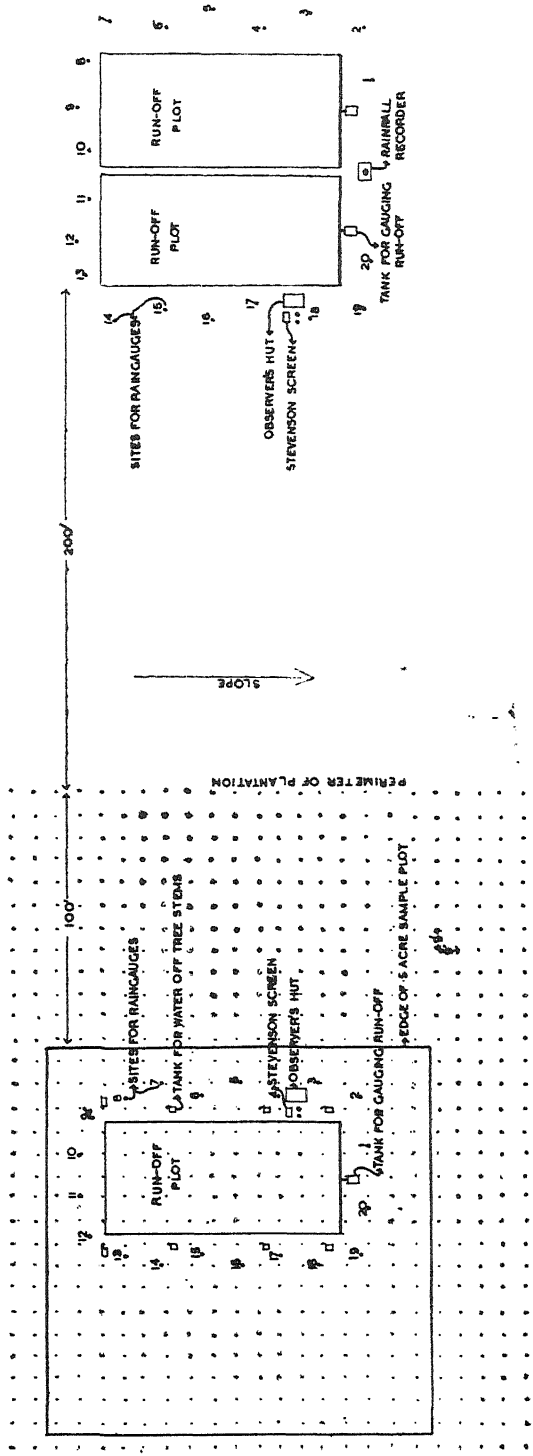


FIG. VII.—INTENSIVE HYDROLOGICAL RESEARCH PROJECT.

errors in the rainfall records, which might ultimately jeopardize the success of the whole investigation. Various methods of screening gauges from wind are now being tested. The most promising of these appears to be the mounting of the gauge in a pit so that the edge of the funnel is exactly level with the soil surface. The pit will prevent the splashing of water into the funnel, and it is hoped that it will provide efficient shelter against wind. For the study of rainfall penetration it is advantageous to have the gauges at soil level, because the interception by shrubs and low undergrowth can then also be studied. If the efficiency of the method is proved, the portable gauges mentioned above will be mounted in this manner.

The mean readings of the gauges inside the plantation will be an estimation of direct penetration and drip, expressed in inches per acre. To this figure a correction must be made to include the water reaching the soil by run-off from the crowns along the boles of the trees. This water will be gauged from eight sample trees selected over the diameter range represented in the experimental stand. After having smoothed the bark at the lower end of their boles, lead guttering will be fitted round them as closely as possible in a spiral. The joint of the guttering with the bark will then be made watertight with a special anti-leak composition called "Plastaleke," and asbestic-bitumen cement. A small tank will be provided, and all water running down the stem will be led into it by the guttering. The water will be measured by running it out of the tank into a measuring can (see Fig. VIII).

The readings will be in gallons of water from each tree. These will be converted to the equivalent in inches per acre as follows: a correlation will be sought between the variate "basal area of the tree" (which is taken as an expression of the tree size), and the variate "run-off water." If a fairly rigid correlation is found, it is clear that the total run-off from all sample trees in gallons, will be to the total basal area of all sample trees, as the total run-off per acre is to the total basal area of a stand of one acre. On the basis of the ratio of basal area of sample trees to basal area of the stand, the total run-off in gallons per acre may then easily be calculated. This total is converted to inches per acre by dividing by 22,625, the equivalent of one inch of rainfall per acre in gallons.

The interception of varying quantities of precipitation received in standard periods of time will be studied, and special readings of the four gauges in the plantation will make it possible to consider individual showers.

It will be attempted to estimate the interception by shrubs and other low vegetation in a similar way, but a method of determining the amount of moisture which runs down the stems of small plants round which it would be impossible to attach guttering, has yet to be developed.

Mist condensation, when no actual rain occurs, is a particular type of interception. It will be ignored except when it is of sufficient magnitude to cause drip or run-off from the tree boles.

A preliminary investigation of rainfall interception is at present being conducted along these lines in a stand of *Populus canescens*, Smith, at Jonkershoek.

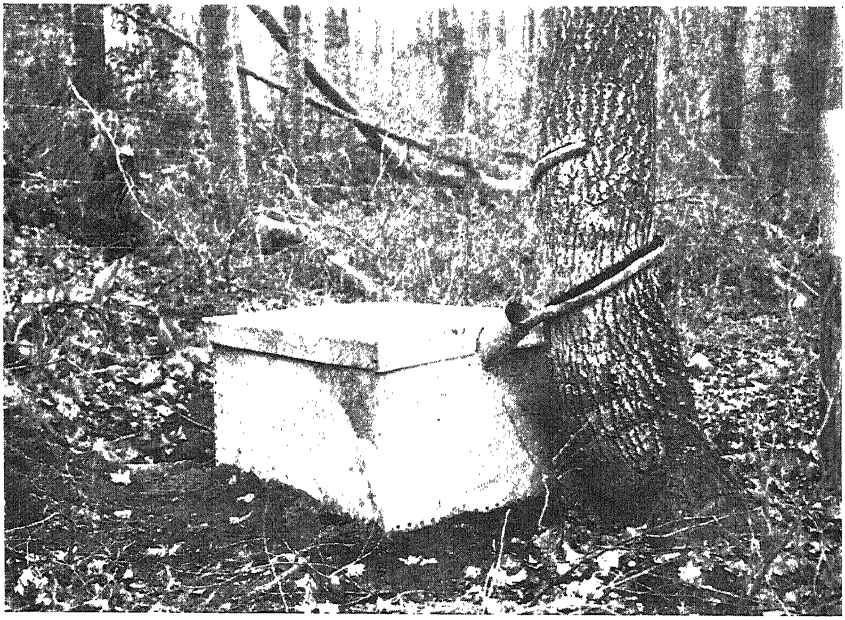


FIG. VIII.—TANK AND GUTTERING for catching run-off from bole of tree.

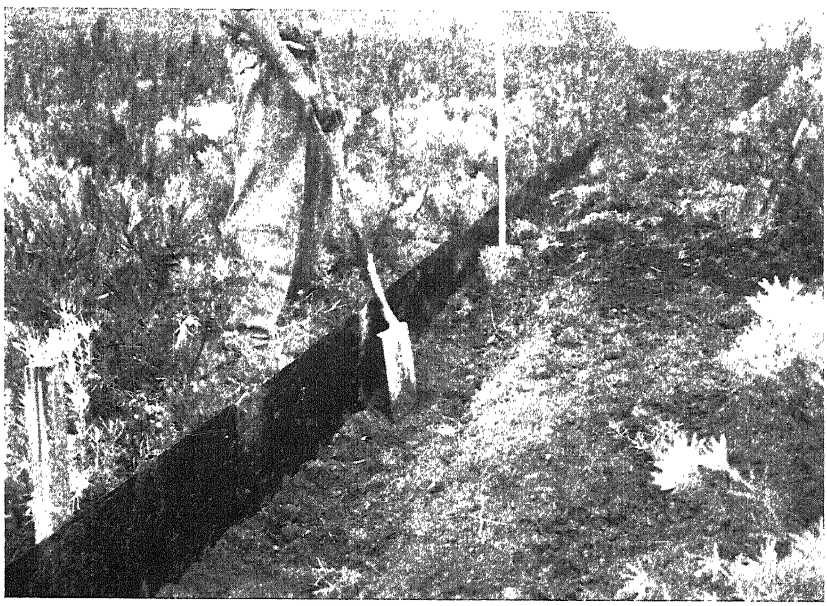


FIG. IX.—METHOD OF ISOLATING RUN-OFF PLOT (left). Iron sheets have been treated with bitumen.

3. *Evaporation.*:

Rainfall interception facilitates evaporation, whereby the moisture is returned to the atmosphere. Evaporation also occurs from the soil surface and the soil itself; even transpiration may be looked upon as a special form of evaporation. A direct quantitative estimate of the moisture returned to the atmosphere in this manner is, however, one of the most difficult problems in hydrological research. All conditions which influence the process in any way, must, therefore, be carefully recorded so that it may be estimated indirectly. These auxiliary observations are described later.

An accurate and reliable relative measurement of the evaporating power of the atmosphere will be given by Livingston-Thone atmometers. The less accurate and reliable Piché evaporimeters will sometimes be used when frequent readings are to be taken and time is a factor to be considered.

The direct evaluation of evaporation from the soil itself will be attempted with the aid of large soil sampling cylinders, which will be weighed before and after filling with undisturbed soil, in order to obtain the weight-loss due to evaporation over various periods. The study of moisture movement in the soil, comprising also the observation of drying-out processes, will cast further light on this problem (see item 5).

4. *Run-off*:

The first moisture that reaches the soil after a dry period will seep away, but at a given point, depending on the nature of the soil and the intensity of downpour, the supply of water will be greater than can be absorbed, and run-off will occur.

Run-off is to be investigated on the one-tenth acre plots already described. The plots will be nearly identical in slope. They will be isolated by flat iron sheets eighteen inches wide, which will be bolted together and buried on edge, one foot below and six inches above the ground (see Fig. IX). At the lower ends of the plots, the run-off will be caught in guttering and led into settling tanks. These tanks are 3ft. x 3ft. x 6ft. and will hold about 200 gallons. They are to be maintained full of water. They will be fitted with 30° V-notches through which all run-off water entering them will escape. Specially designed water level recorders will give accurate records of the flows through these notches. Tests are being conducted to find a suitable formula which will give estimates of the discharge through a 30° V-notch on the basis of records of the head of water over the apex of the V. The application of the V-notch method of gauging water will make it possible to deal satisfactorily with the large flows of water which are expected from the relatively large plots. The 30° V-notch, seven inches deep, will take up to about 3,915 gallons per hour, or, in other words, the notch could accommodate the total quantity of water deposited on the plot by 1.7 inches of rain per hour, if complete run-off were to occur. The gauging will be highly accurate, for it will commence with a flow of about one gallon per hour, which is equivalent to a head of about one-tenth of an inch in the apex of the V.

Single correlative plots are to be established later, on other sites, in order to test the effect of differences in slope, soil, rainfall, etc.

5. *Seepage and soil moisture* :

The study of the water in the soil presents many technical difficulties. Chief among these is the task of estimating moisture and moisture movement in undisturbed soil. The work may be classed under two headings; the investigation in the field of moisture movements in undisturbed soil and the determination in the laboratory of characteristic soil moisture constants of samples collected in the field. Work of the second class is well known. It includes the determination of the maximum water-holding capacity, the moisture content, the moisture equivalent and the air-dry moisture content of the soil. These data will be determined by standard laboratory methods.

Soil water movement may be due to gravity, that is, the percolation of free water due to capillary pull in the soil, or due to evaporation causing vapour movement in the soil. We are mainly concerned with the downward movement of absorbed water during and after rain, and the drying out processes in the soil due to evaporation and the absorption of moisture by plant roots.

The quantity of free water percolating to a given depth will be estimated electrically. It is based on the fact that a wet soil offers less resistance to an electrical current than a dry one. Pairs of electrodes will be forced into undisturbed soil at various depths, say at six inches, eighteen inches, two feet six inches, three feet six inches, four feet six inches, two feet six inches (see Fig. X). The positive electrodes will be connected to the six points of a six-way switch, which will be connected to a six volt battery, from which a wire will pass to a Gossen mavometer, which will in turn be connected with the negative electrodes. The mavometer will give readings in volts or amperes, so that the resistance in ohms offered by the soil at any depth may be calculated on the basis of Ohm's law :

$$\text{Resistance in ohms} = \frac{\text{Potential difference in volts}}{\text{Current in amperes.}}$$

As this resistance is immediately affected by a change in the moisture content of the soil, the apparatus may be used to determine the time taken for water to penetrate to a given depth and to what depth the soil will become wet after a given quantity of rain has fallen. If the moisture equivalent of the soil being tested has been determined, it will be possible to estimate the quantity of water required to wet the soil to a given depth. This figure will be an estimation of the amount of moisture absorbed by the soil. These observations may be supplemented by lysimeter readings, if necessary.

The electrical apparatus is capable of recording the drying out of the soil in the same manner as the increase in soil moisture. The combined effect of evaporation and transpiration can thus be traced by this method.

6. *Transpiration* :

No method has been selected yet for the direct estimation of water transpired by plants.

7. *Erosion* :

The eroded material collected in the settling tanks for run-off water, will be measured in order to gauge the extent of erosion under

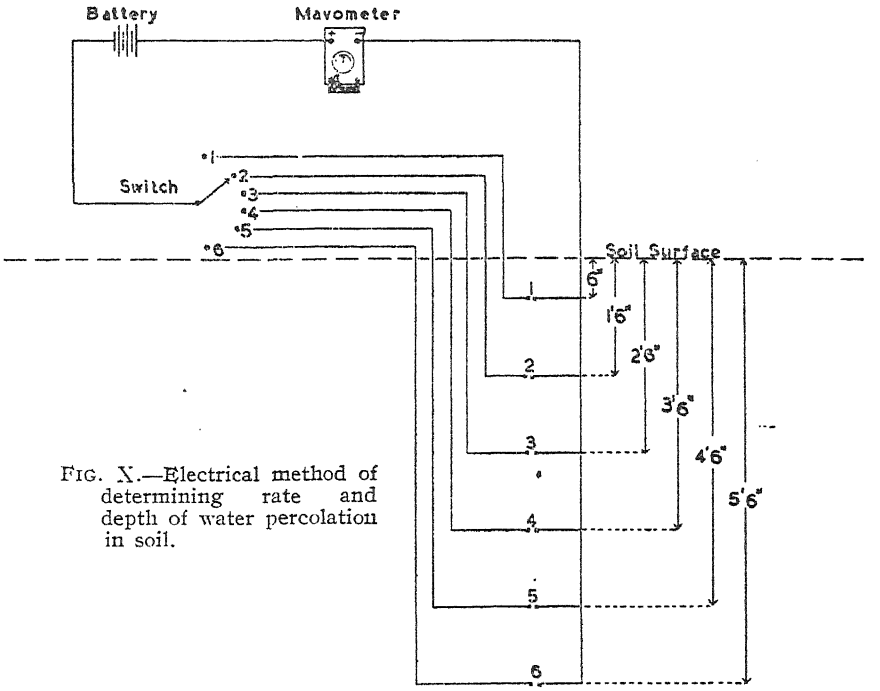


FIG. X.—Electrical method of determining rate and depth of water percolation in soil.

various treatments. Samples will also be taken of water flowing from these tanks, in order to estimate the quantity of material carried in suspension and in solution.

8. *Auxiliary observations*:

The auxiliary observations have either an indirect bearing on the main question, or are concerned with phenomena which are considered to be of subsidiary importance in this investigation. They are climatic, pedological or botanical in character.

Climatic factors affect the rate and duration of evaporation and transpiration. The duration and intensity of sunshine is to be recorded by a Whipple-Casella instrument. Intensity of light inside and outside the forest is to be analysed by using a photo-electric cell and a set of coloured filters. Radiation will be gauged by black and white bulb Livingston-Thone atmometers. Temperature and atmospheric humidity will be recorded by two combined recorders, which will be placed in Stevenson screens inside and outside the plantation. Snap readings will be taken with a hand aspirated Friez psychrometer, which will also be used to set the recorders. Wind intensity will be gauged with a special portable type of cup anemometer.

Pedological investigations which will contribute to a proper appreciation of soil moisture conditions, are:

(a) the mechanical analysis of the soil at various depths.

(b) the determination of humus content by ascertaining the loss of weight on ignition.

(c) the recording of soil temperature and its variations.

(d) the determination of specific gravity of soil.

(e) the estimation of pore space of soil.
(f) water-holding capacity of soil.

Repeated soil studies will trace any changes which might develop as the result of treatment and botanical studies will be undertaken to show the development of flora under the different treatments.

Conclusion.

All these investigations have been planned on a semi-permanent basis. The main research period will correspond with the rotation of the most important tree species planted, which will be about forty years. Supplementary investigations will be extended over several rotations, however, so as to secure conclusive data upon the ultimate effects of the treatments.

In the meantime all observations in this relatively unexplored field will be of interest. There is already reason to believe that records of existing conditions will disclose hydrological relationships which may amend traditional concepts as to the disposal of precipitation.

Summary.

Methods and technique, which are being applied in hydrological research at the Jonkershoek research station in the South African winter rainfall region, are described.

The investigations fall into two groups: research on a large scale into the effect of various treatments on streamflow, and research into the detailed hydrological effects of various treatments applied on experimental plots located on a carefully selected uniform site. Details are given of the organization of observations, and of the apparatus to be used. The treatments to be investigated are the following types: afforestation, veld-burning, veld-burning with grazing and protection of the native flora. In each case observations will be made to determine how these treatments affect the disposal of precipitation.

The technique of gauging precipitation, rainfall interception, evaporation, run-off, seepage, erosion, streamflow and other natural phenomena, is described.

REFERENCES.

(1) Barnes, A. A.: Hydraulic Flow Reviewed. London, Spon.

(2) Bates, C. G. and Henry, A. J.: Forests and Streamflow. Experiment at Wagon Wheel Gap, Colorado. *Monthly Weather Review, Suppl.* No. 30, 1928.

(3) Engler, A.: Einfluss des Waldes auf den Stand der Gewässer. *Mittl. d. Schweiz. Zeitscr. f. d. forst. Versuchsw.* Bd. XII, 1919.

(4) Francis, J. B.: "Lowell Hydraulic Experiments." 1883.

(5) Hellman, G.: Resultate des Regenmessungs Versuchsfeldes bei Berlin, 1855 bis 1891. *Met Zeitsch.* 1892.

(6) Kriel, J. P.: Jonkershoek Gauging Weirs. Unpublished. 1939.

(7) Parshall, R. L.: The Parshall Measuring Flume. *Colorado Experiment Station, Fort Collins. Bull.* No. 423, March, 1936.

(8) .....: Parshall Flumes of large size. *Colorado Experiment Station, Fort Collins. Bull.* No. 386, May, 1932.

(9) Thomson: British Assen. Report, 1858.

(10) Wood, O. M.: The Interception of Precipitation in an Oak-Pine Forest. *Ecology*, Vol. 18, No. 2, April, 1937.

(11) Zon, R: Forests and Water in the Light of Scientific Investigation. Gvt. Ptg. Office, Wash., U.S.A., 1927.

HOUTPRESERVERING.

DEUR J. H. VAN WYK EN P. J. A. LOSEBY.

(*Bosprodukte-Inrigting, Pretoria*)

(This article was first published in English in issue No. 2 of this Journal, April, 1939.)

ONDER houtpreservering word verstaan die blywende beskerming van hout teen alle faktore wat dreig om sy bederf en vernietiging te veroorsaak. Die houtpreserveerder trag om die hout deur middel van verskeie prosesse so giftig en afwerend moontlik teen hierdie faktore te maak, en sodoende die beste moontlike diens daaruit te kry. Die oudste en mees doeltreffende middel om hierdie doel te bereik is om die hout met bederfwerende chemikalië te behandel.

1. DIE ONTWIKKELING VAN HOUTPRESERVING IN SUID-AFRIKA.

Suid-Afrika se enigste voorrade plaaslik gekweekte houtsoorte was in vroëer dae, met 'n paar uitsonderings, nie duursaam nie, en alhoewel daar 'n groot aanvraag was na die paar duursame soorte, soos Nieshout ens., kon hul beperkte voorraad weinig doen om die steeds toenemende oortuiging dat die gebruik van plaaslik gekweekte hout vir heiningpale, telegraaf- en transmissiepale nie die moeite wérd was nie, te weerlê. Om hout te gebruik wat in die bestek van 'n paar jaar deur rysmiere verslind, deur verrotting vernietig, of deur die larwes van kewers vol gate gemaak sou wees, is onweerlegbaar as onekonomies geag.

Nadat die Staat begin het om die beperkte natuurlike houtvoorrade van die land deur middel van 'n kragtige beleid van bebossing met uitheemse soorte aan te vul, het dit 'n probleem geword hoe om 'n afset te vind vir die benutting van toenemende hoeveelhede paalhout, die grootste gedeelte waarvan nie duursaam was nie. Hierdie vraagstuk is toe wetenskaplik aangepak en noodgedwonge is die toepassing van houtpreservering, wat totnogtoe in Suid-Afrika onbekend was, in die lewe geroep.

Sedert die klein begin wat in 1922 gemaak is het die Unie Departement van Bosbou sy werksaamhede in verband met houtpreservering geleidelik uitgebrei. Tabelle vir die behandeling van byna alle uitheemse houtsoorte wat in die land gekweek word is ontwerp en met die verbetering van die tegniese prosesse is geleidelik vordering gemaak. Die vernaamste kenmerk van hierdie werk was egter om die relatiewe hoedanighede van bekende preserveermiddels en spesiaal saamgestelde mengsels daarvan deur middel van dienstoetse vas te stel. Die afwerende werking van hierdie chemikalië teen rysmiere is op 'n terrein te Pienaarsrivier, Distrik Pretoria, uitgetoets, daar miere in hierdie omgewing besonder veelvuldig voorkom. Behandelde houtmonsters is hier begrawe en aan 'n gereelde ondersoek onderwerp. Die relatiewe giftigheid van die preserveermiddels vir houtverrottende swamme is op 'n klein skaal deur gekontroleerde proefnemings op 'n groot diepte in een van die Witwatersrandse goudmyne vasgestel. Hierdie ondersoek is egter nie tot klein monsters beperk nie, maar die

mees belowende preserveermiddels is aan uitgebreide proefnemings onderwerp met produkte werklik in gebruik. Duisende behandelde telefoon-, elektriese transmissie-, heiningpale en dwarslêers is in verskillende streke in alle dele van die land in diens geneem en is van tyd tot tyd ondersoek.

Die uitstekende resultate wat verkry is het daartoe aanleiding gegee dat verskeie preserveer-installasies op kommersiële skaal opgerig is en daarvan is vyf reeds in verskeie dele van die land werksaam. Namate die verbruiker geleer het om die voordele van houtpreservering te waardeer het die aanvraag vinnig toegeneem en op die oomblik word moeilikhede ondervind om al die materiaal waarna gevra word te voorsien. Daar kan nou met sekerheid op aanspraak gemaak word dat die tegniek van houtpreservering op 'n gesonde praktiese basis geplaas is en daar bestaan geen twyfel meer dat die gebruik van behandelde hout ook sy plek in die staatshuishoudkunde van Suid-Afrika inneem nie.

Die Bosprodukte-Inrigting te Pretoria-Wes is die hoofkwartiere vir houtpreservering, en die staf daar sal met graagte inligting oor hierdie onderwerp verstrek en enige vrae beantwoord.

II. Die Struktuur van Hout.

Alhoewel hout na 'n soliede vaste stof lyk as dit met die blote oog bekyk word, sal ondersoek met 'n mikroskoop aan die lig bring dat dit in werklikheid uit 'n massa hol selle of pypies saamgestel is en 'n struktuur vorm wat enigsins na 'n heuningkoek lyk. Hierdie houtstof bestaan dus uit selwande wat uit sellulose saamgestel is en 'n stof bekend as lignin wat die wande aanmekaar voeg. In 'n lewende boom is die selle gevul met 'n waterige vloeistof, of sap, wat tot 66 persent van die gewig van nat hout kan bedra. Hierdie water verdamp en die selle word met lug gevul terwyl die hout uitdroog nadat dit gekap is.

Loofhout- en Naaldhoutsoorte.

Houtsoorte word in twee hoofgroepe verdeel wat as Loofhout- en Naaldhoutsoorte bekend staan. Die botaniese verskil tussen die twee groepe is op die vorm van die sade gebaseer en plantkundiges verwys na loofhoutsoorte as Angiosperms en naaldhoutsoorte as Gimnosperms. Die populêre beskrywing van die groepe dui aan dat loofhoutsoorte uit bome met breë blare en naaldhoutsoorte uit bome met naalde of smal skubagtige blaartjies bestaan. Verskille in botaniese eienskappe word ook van verskille in selstruktuur vergesel.

Die geelhout-, seder-, sipres- en dennesoorte word as naaldhoutsoorte geklassifiseer, terwyl die meeste van ons inheemse bome, die uitheemse eucalyptus-, wattel- en ander soorte in die groep van die loofhoutsoorte sorteer. Die betekenis van hierdie onderskeiding sal in die hieropvolgende bespreking van sekere gesigspunte van hierdie onderwerp besef word.

Saphout en Kernhout.

As die stam van 'n boom dwarsgesaag word vertoon die blootgestelde oppervlakte dikwels 'n donker gekleurde kern aan die binnekant, wat deur 'n ligter gekleurde wand omring word. In die lewende boom bevat die buitenste gedeelte van die stam die lewende selle en word saphout genoem, terwyl die binneste kern wat nie meer fisiologies werk nie kernhout genoem word.

Alhoewel daar gewoonlik 'n duidelike verskil in kleur is tussen saphout en kernhout, soos in foto No. 2 aangetoon, is die verskil in kleur in die geval van sommige soorte nouliks waarneembaar.

Houtstrukluur en Preservering.

'n Duidelike begrip van houtstruktuur is noodsaaklik om die beginsels van houtpreservering te verstaan. Om hout blywend te beskerm is meer as 'n dun oppervlaktelagie van die preserveermiddel nodig. Die hout moet tot 'n sekere diepte met die preserveer-vloeistof deurdring word. Dit kan in werklikheid onder origens gelyke omstandighede vasgestel word dat die dienstyd wat van behandelde hout verkry word, afhanklik is van die hoeveelheid preserveermiddel wat oorspronklik in die hout aanwesig was.

Dit is duidelik dat die sap wat in die selle van lewende bome aanwesig is eers verwyder moet word om die preserveermiddel tot die vereiste mate in die hout te laat deurdring. Dit word teweeggebring deur die hout eers deeglik te laat uitdroog voordat dit behandel word. Die preserveermiddel word dan in die leë selle forseer deur een van die metodes wat later beskryf sal word.

As die wande van die selle heeltemal ondeurdringbaar vir vloeistowwe was, sou dit vir die preserveermiddel onmoontlik gewees het om in die hout in te trek. Die aanwesigheid van talryke klein openings of gaatjies in die selwande maak dit egter moontlik. In die kernhout van baie soorte word hierdie onderlinge verbinding tussen die selle verhoed deur sekere fisiologiese veranderings in die hout, en die deurdringing van die preserveermiddel word dus tot die saphout beperk. Dit is egter vasgestel dat genoegsame preservering aan die paal as geheel verskaf word as die saphout heeltemal deurtrek is.

III. Vernietigende Faktore.

Hout wat aan die opelug blootgestel of in die grond geplant is verloor sy diensbaarheid na 'n sekere tyd. In Suid-Afrika word die agteruitgang en vernietiging van hout hoofsaaklik deur verrotting, rysmiere en die larwes van houtvretende kewers veroorsaak.

Verrotting.

Verrotting is 'n organiese proses wat die ontbinding van die houtbestanddele as gevolg het en word deur primitiewe plante, houtverrottende swamme genoem, veroorsaak. Om te bestaan het hierdie swamme wat in hout lewe, lug, vogtigheid, 'n gepaste temperatuur en voedsel in die vorm van hout nodig. Hout onder water sal dus nie verrot nie omdat daar nie genoeg lug aanwesig is nie, terwyl hout wat aan 'n lugvogtigheid van minder as 20 persent blootgestel is ook gesond sal bly. Dit verklaar waarom huisraad en binnehoutwerk van beleëgemaakte hout vervaardig byna ewigdurend is. Wat temperatuur betref is die omstandighede vir groei die gunstigste tussen 65°F en 95°F. Die gewone temperature gedurende die somermaande is dus besonder gunstig vir die ontwikkeling van swamme. Die lae temperatuur wat gedurende die wintermaande heers verhinder die groei maar maak nie die swamme dood nie. Hulle bly slapend totdat die warm weer van die volgende lente weer aanbreek. Onder opelug omstandighede is die voggehalte van hout, veral die gedeeltes wat met die grond in aanraking kom, gewoonlik groter as die minimum wat vir die groei van swamme nodig is en sulke hout sal dus blootgestel wees aan verrotting.

Die kwesbaarste gedeeltes is dié dele van die hout naby en onmiddellik onder die oppervlakte van die grond en enige voëe, barste, gate en ander skeure waar vogtigheid versamel.

Die mees praktiese manier om verrotting te voorkom is om die voedselvoorraad van die swamme te vergiftig deur die hout met giftige chemikalië te laat deurtrek.

Insekte.

Larwes van kewers van die geslag *Lyctus* of houtpoeier-kewers, veroorsaak baie skade aan die saphout van die meeste loofhoutsoorte in Suid-Afrika, terwyl ander verwante geslagte aansienlike skade aan naaldhoutsoorte in sommige dele van die land aanrig.

Daar byna al die boupale wat vir rowwe bouwerk soos skure gebruik word, asook heiningpale en ander materiaal, verkry word uit dunnings van jong onvolwasse plantasies, bestaan hulle byna heeltemal uit saphout. Die gevolg is dat baie boere en bou-ondernemers die ondervinding beleef het dat hout deur larwes van hierdie houtvretende kewers binne 'n paar jaar vol gate gevreet is.

Kewers wat nat hout aanval is nie van veel belang nie. Pas afgeskapte loofhoutpale word soms egter deur Phoracanthakewers aangeval, en die larwes daarvan vreet gate van 'n kwart tot 'n half duim in deursnee tot in die kernhout. As die bas waaronder hulle skuil hou en broei onmiddellik afgemaak word nadat die pale gekap is sal hulle vry van sulke aanvalle wees.

Rysmiere.

Van al die houtvernietigende faktore is rysmiere waarskynlik die vraatsugtigste. Daar is meer as vyftig bekende houtvernietigende rysmiersoorte in hierdie land waarvan slegs 'n paar egter van ekonomiese belang is. Hulle rig veral skade aan in Natal, Transvaal, Oranje-Vrystaat, die Transkei en die noordelike gedeelte van die Kaapprovinsie.

Rysmiere, net soos bye, is sosiale insekte wat in kolonies lewe met 'n koningin en verskeie gespesialiseerde stande wat elk sy besondere diens het om te verrig namate sy geskiktheid. Met die verskillende stande word veral onderskeid gemaak tussen dié wat belas is met voortbrenging, verdediging, versameling van voedsel en die instandhouding van die nes.

Rysmiere wat hout vreet verslind dit deur hardgetande onderkake van saagagtige formaat. Gewoonlik word die sagter dele van die hout verkies, en skade deur rysmiere word dikwels gekenmerk deurdat die lentehout uitgevreet word terwyl die harder somerhout-ringe onbeskadig bly. Dit is opmerklik dat rysmiere self nie in staat is om hout te verteer nie, maar is vir die metabolisme daarvan afhanklik van talryke klein organismes wat in hul ingewande aanwesig is. Die meeste skade word in hierdie land deur rysmiere wat onder die grond lewe aangerig. Hulle val hout aan wat in of op die grond is en is ook in staat om ander hout wat nie met die grond in aanraking is nie deur middel van gange te bereik. 'n Tipiese voorbeeld van skade deur miere is onbehandelde pale wat dikwels naby of net onder die oppervlakte van die grond afgevreet word. Ander soorte wat as droëhout-rysmiere bekend is lewe nie in die grond nie en is in staat om enige hout aan te val wat die insekte kan bereik terwyl in die gevleulde stadium.

Die beste middel om skade deur rysmiere te voorkom is om aanvalle af te weer deur die hout deeglik met 'n doeltreffende preserveermiddel te deurtrek.

Ander Faktore.

Houtboorders wat hout in seewater beskadig is in hierdie land 'n faktor van minder belang as dié wat reeds genoem is.

Ook hout wat nie geverf is nie en aan die opelug blootgestel word kry baie gou die bekende verweerde voorkoms wat deur die herhaalde swel en krimp van die buitenste vesels veroorsaak word en aan veranderinge in vogtigheidstoestande te wyte is. Sulke verwering beinvloed die sterkte van hout en benadeel sy voorkoms.

Brand word vir die klas materiaal onder bespreking nie as 'n groot gevaar beskou nie. Die grootste gedeelte van die materiaal wat tot nou toe met preserveermiddels behandel is, is onder omstandighede geplaas waar die enigste brandgevaar, as dit as 'n gevaar beskou kan word, deur veldbrande kan ontstaan. Van die duisende heining- en ander pale wat in baie dele van die Unie sedert 1922 in diens geneem is, is nog geen geval van vernietiging deur veldbrande rapporteer nie.

IV. Hout-Preserveermiddels.

Eienskappe van 'n goeie Hout-preserveermiddel.

Die noodsaaklike kenmerke van 'n geskikte houtpreserveermiddel is as volg :—

1. Dit moet vir houtvernietigende faktore wat beveg moet word tot 'n groot mate giftig en afwerend wees.
2. Dit moet van so'n geaardheid wees dat dit instaat sal wees om deur die hout opgeneem te word en dit te deurtrek.
3. Dit moet 'n groot mate van bestendigheid besit. Om blywende beskerming te verseker moet die preserveermiddel nadat dit in die hout ingetrek het nie maklik verdamp of uitloog nie.

Afgesien van bogenoemde is ook die volgende eienskappe wenslik :—

4. Dit moet nie op metale invreet nie aangesien ystergereedskap by die behandelingsproses algemeen gebruik word en metaalkramme en onderdele gewoonlik aan behandelde hout geheg word.
5. Dit moet nie die sterkte van die hout ongunstig beinvloed nie.
6. Dit moet nie 'n onaangename reuk hê nie en vir sekere doeleindes moet dit nie die natuurlike skoon voorkoms van die hout belemmer of die oppervlakte vir verf bemoeilik nie.
7. Dit moet nie die ontvlambaarheid van hout vergroot nie.
8. Die prys van die preserveermiddel moet so wees dat dit sy gebruik prakties moontlik maak.

'n Baie groot aantal chemikalië en mengsels daarvan word as preserveermiddels gebruik maar slegs enkele, indien enige beantwoord aan al die vereistes. Die volgende is doeltreffend en ekonomies gevind vir gebruik onder Suid-Afrikaanse omstandighede :—

Kreosoot.

Kreosoot wat vir houtpreservering gebruik word is 'n distillaat van koolteer of kooksoondteer. Dit is 'n bruin of bruin-swart olieagtige vloeistof met 'n hoë kookpunt en kenmerkende reuk. Dis 'n hoogs ingewikkelde mengsel van verskillende organiese stowwe en sy doeltreffendheid kan nie aan enige van die bestanddele in besonder toegeskryf word nie. Wat kwaliteit betref kan kreosoot baie variëer en moet volgens bepaalde spesifikasies gekoop word. Die samestelling daarvan is beide deur die Britse Standaarde-Instituut en die Amerikaanse Hout-

preserveerdersvereniging gestandardiseer. Laasgenoemde spesifiseer 'n minder vlugtige kreosoot wat vir Suid-Afrikaanse omstandighede waarskynlik meer geskik is.

Teneinde 'n geskikte preservering onder gewone opelug omstandighede te verkry is dit nodig dat tenminste 5 lb. (of 'n half-gelling) kreosoot per kubieke voet hout vir eucalyptus-soorte absorbeer word, terwyl hout van dennesoorte enigsins swaarder deurtrek moet word.

Kreosoot word in Suid-Afrika vervaardig en is beide in dromme en in groot tenktrokke verkrygbaar.

Ru-olie.

Ru-olie het geen gifwaarde teen swamme nie. Sy waarde as 'n preserveermiddel bestaan daarin dat dit 'n neiging besit om hout waterdig te maak en dit dus benede die voggehalte te hou wat vir die bestaan van swamme nodig is. Dit word ook verwag om te verhoed dat hout oormatig sal bars. 'n Voordelige gebruik vir ru-olie bestaan egter daarin dat dit geskik is om giftige preserveermiddels, soos byvoorbeeld kreosoot, mee te verdun. Die ru-olie in die geval van 'n kreesoot-ru-olie mengsel word om redes van besparing as 'n verdunningsmiddel gebruik en die mengsel behoort nie minder as 60 persent kreosoot te bevat nie. Die behandeling daarmee wat aan die hand gegee word is dieselfde as vir kreosoot alleen.

Sinkkloriede.

Sinkkloriede is 'n sout wat in water oplosbaar is, en om hout te behandel word sulke oplossings tot 5 persent sterkte gebruik. Om hout doeltreffend teen verrotting te vrywaar is dit nodig dat minstens 'n halwe pond droë sout per kubieke voet hout opgeneem word. Die sterkte van die oplossing wat nodig is word bepaal deur die hoeveelheid oplossing wat die hout kan absorbeer.

Die grootste nadeel by die gebruik van sinkkloriede om hout teen verrotting te beskerm is die feit dat dit in water oplosbaar is. Dit maak die gebruik daarvan in baie nat omgewings, waar dit moontlik kan uitloog, nie raadsaam nie. Uit ondervinding in Suid-Afrika het geblyk dat dit geskik is om houtkewers af te weer, maar dat dit betreklik onskadelik is teen rysmiere. Die beste gebruik word hiervan gemaak vir die behandeling van pale vir die bowebou van drukgange vir beeste, vir priëels, skure, ens. wat nie in aanraking met die grond kom nie. 'n Nuttige en ekonomiese samestelling is om 'n paal eers volle lengte met sinkkloriede en dan slegs die onderent wat in die grond geplant word met kreosoot te behandel. Sinkkloriede word in die vorm van droë sout in dromme in Suid-Afrika ingevoer.

Sinkkloriede en Arseenoksiede.

Teneinde sinkkloriede teen rysmiere meer doeltreffend te maak word dit met arseentrioksiede gemeng. Die mengsel wat teenswoordig gebruik word bestaan uit 1 persent arseenoksiede en 3 persent sinkkloriede in oplossing met water. Alhoewel hierdie mengsel nie so duursaam is as kreosoot nie, is dit baie geskik gevind vir behandeling teen rysmiere, houtkewers en verrotting.

Ander Soute.

Sinksulfaat het tot 'n sekere mate ook 'n waarde as 'n preserveermiddel teen verrotting. Dit word op groot skaal vir die behandeling van mynhoute in die Witwatersrand-streek gebruik, waar die sout as 'n goedkoop byproduk van die goudafskeidingsproses verkry word.

As preserveermiddels is daar ook nok verskeie ander organiese en anorganiese gepatenteerde mengsels wat verdienstelik is.

V. Voorbereiding van Pale vir Preservering.

Kapseisoen.

Bevredigende diens kan van behandelde hout alleen verkry word as dit gedurende die hele proses op die regte manier hanteer word. Om by die staande boom te begin is die eerste vraag om te besluit welke tyd van die jaar die geskikste is om die boom af te kap. Dit is nog nie vasgestel dat kaptyd 'n aanmerklike invloed op die inherente duursaamheid van hout het nie, mits dit behoorlik versorg word nadat dit afgekap is. Skade aan pale kan egter deur kewers en verrotting aangerig word terwyl hulle voor behandeling uitdroog en die beste tyd om die pale te kap en uit te droog sal derhalwe gedurende die winter wees wanneer hierdie vernietigende faktore die minste invloed het.

Afmaak van Bas.

Sodra die boom afgekap is, moet bepaal word wat die regte behandeling moet wees van die paal wat daaruit verkry kan word. Dit is nie raadsaam om die pale onmiddellik na die vereiste lengte af te saag nie. Dit moet liewer gedoen word as die paal droog is, sodat gebarste ente afgesaag kan word. Bas is ondeurdringbaar vir vloeistowwe en moet dus heeltemal verwyder word. Dit word die maklikste afgemaak terwyl die pale nog nat is en moet dus so gou moontlik nadat die pale afgekap is verwyder word. Die Departement het 'n eenvoudige instrument ontwerp om bas mee af te maak wat deur enige smid gemaak kan word. 'n Stuk 1-duim ronde yster word aan die een ent platgeslaan om 'n 3½ duim wye kant te vorm wat dan tot 'n stomp sny-hoek geslyp word sodat die kant effens hol is om by die vorm van die paal te pas. 'n Swaarder tipe word vir eucalyptussoorte as vir dennesoorte gebruik. Die instrument kos omtrent vyf sielings. Indien slegs 'n klein aantal pale betrokke is kan 'n graaf of 'n byl gebruik word.

Die snelheid waarmee pale uitdroog word aanmerklik vergroot deur die bas te verwyder.

Beleëmaak.

As 'n algemene reël, en veral in die geval van preserveermiddels van 'n olierige aard, kan verklaar word dat lugdroë hout preserveermiddels makliker absorbeer as nat hout. Om die beste resultate te verkry is dit dus belangrik dat die pale droog genoeg moet wees voordat dit behandel word. Waar dit vir die preserveermiddel onmoontlik is om heeltemal in die hout in te trek, word na 'n deeglike behandeling van die buitenste lae gestreef wat dan 'n beskermende skild om die paal as geheel vorm. Hout wat nie lugdroog is nie sal geneig wees om na die behandeling te bars, waardeur die onbehandelde kern van die hout dan miskien blootgestel kan word.

Nadat die pale gekap en die bas afgemaak is, moet hulle op so'n manier gestapel word dat die lug maklik daartussen deur kan trek. Die onderste ry pale moet 'n goeie afstand bokant die grond wees en die daaropvolgende rye moet deur middel van dwarshoute, soos in foto No. 3 aangetoon, geskei word. Deur pale sorgvuldig te stapel word ook verseker dat hul so reguit moontlik sal bly.

Indien die nodige apparaat beskikbaar is moet voggehalte teen die einde van die uitdrogingsperiode weekliks bepaal word. Die beste

gemiddelde syfer vir die voggehalte word verkry van monsters wat naby die middel van die paal uitgeboor word. As algemene leidraad vir diegene wat nie die fasiliteite het om voggehalte te bepaal nie kan verklaar word dat dennepale, 3 tot 5 duim in deursnee, gewoonlik in 4 tot 6 maande voldoende sal uitdroog en eucalyptus- en wattelpale van dieselfde afmetings van 6 tot 9 maande sal neem.

VI. Behandelingsprosesse wat by Houtpreserving Toegepas Word.

Die groot aantal prosesse wat by houtpreservering toegepas word kan gemakshalwe in die volgende twee klasse verdeel word :—

(a) Oppervlakkige prossesse.

(b) Deurdringingsprosesse.

A. Oppervlakkige Prosesse.

Die oppervlakkige prosesse verwys na daardie metodes van behandeling wat die beskerming van die hout deur slegs 'n bedekking aan die oppervlakte ten doel het. Indien dit moontlik was om hierdie beskermende deksel te behou sou dit 'n geskikte beskerming vir gesonde hout gewees het. Die moontlikheid bestaan egter dat dit afgeskaaf of deur fyn barsies aan die oppervlakte van die hout gebreek sal word, waardeur die effek van die beskermende omhulsel heeltemal verlore mag gaan. Die gesonde uiterlike voorkoms mag dan 'n verrotte binne-gedeelte bedek. Ook, as hout nie heeltemal gesond is nie, d.w.s. waarin verrotting reeds begin het, oppervlakkig behandel word, mag die verrotting verder ontwikkel en die hout in die loop van tyd onbruikbaar maak. Waar die oppervlakte van gesonde hout egter nie blootgestel is om afgeskaaf te word of om fyn barsies te kry nie, het hierdie behandeling 'n sekere waarde. Dit is goedkoop, kan maklik uitgevoer word en is nuttig as slegs 'n klein hoeveelheid hout behandel moet word. Dit is veral nuttig om hout by die werk te behandel.

Kwasbehandeling.

Kwasbehandeling beteken eenvoudig olie of verf met 'n kwas aan die oppervlakte van die hout te smeer. Die beste resultate word met beleëgemaakte hout verkry. Kreosoot en karbolineum is olies wat aanbeveel word en moet, om die grootste voordeel daaruit te trek, warm aangesmeer word. In elk geval trek hierdie vloeistowwe gewoonlik maar baie vlak in die hout in en sorg moet gedra word dat alle barste, krake en laste goed bedek word. Die warm preserveermiddel behoort driekeer aangesmeer te word. Die eerste laag moet toegelaat word om vir minstens 24 uur te droog voordat die tweede laag aangesmeer word en die laaste laag word aangesmeer net voordat die hout in posiesie geplaas word.

Bevredigende resultate kan verkry word as die preserveermiddel versigtig toegedien word. Indien behoorlike voorsorgmaatreëls egter nie geneem word nie sal die behandeling ook nie die gewenste uitwerking hê nie.

Kwasbehandeling het die voordeel dat dit nie 'n duur installasie vereis nie en die preserveermiddel kan maklik toegedien word. Dit is veral geskik om pale in ontoeganklike dele op 'n plaas te behandel en ook om bouhout by die werk te behandel.

Indompeling.

Indompeling is meer effektief as kwasbehandeling omdat die preserveermiddel in alle barste en skeure van die hout in trek. Daar bestaan ook meer sekerheid dat die hele oppervlakte van die hout behandel is. Hiervoor is 'n tenk nodig wat groot genoeg is om die hout heeltemal in te dompel.

Indompeling word op groot skaal toegepas om te verhoed dat gesaagde hout, waarvan die oorspronklike kleur van die produk, b.v. kisplankies, behoue moet bly en nie sal blou word nie.

Sproeiing.

Preserveermiddels kan deur middel van 'n pomp op die hout gesproei word. Ook in hierdie geval dring die preserveermiddel beter in krake en skeure in, en word 'n beter bedekking van die houtoppervlakte verkry as met kwasbehandeling. Hierdie metode is veral nuttig as pale, wat alreeds in diens is en tekens van verrotting of aanvalle deur rysmiere toon, behandel moet word.

Die oppervlakkige prosesse moet, in vergelyking met 'n deeglike versadiging van die hout met die preserveermiddel, as baie minderwaardig beskou word en moet slegs toegepas word as die ekstra onkoste of ongerief die gebruik van een van die deurdringingsprosesse nie regverdig nie.

B. Deurdringingsprosesse.

By die deurdringingsprosesse word daarna gestreef om die preserveermiddel diep in die hout te laat intrek, sodat die hele paal daarmee versadig word, of as dit nie moontlik is nie, sodat tenminste die saphout heeltemal daarmee deurtrek word. Sodoende word die kanse tot 'n minimum beperk dat onbehandelde hout blootgestel sal word as die oppervlakte beskadig word. Weëns die groter hoeveelheid preserveermiddel wat met hierdie prosesse deur die hout opgeneem word, is uitloging en verdamping van minder belang. Hierdie prosesse is daarom baie meer doeltreffend as die oppervlakkige prosesse. Die werklike diepte wat die preserveermiddel in die hout intrek sal van die houtsoort en die besondere proses wat toegepas word afhang.

Deurdringingsprosesse is duurder as oppervlakkige prosesse en vereis ook meer uitvoerige uitrusting. Hulle kan in twee groepe verdeel word :—

(a) Drukprosesse, waar druk hoër as dié van die atmosfeer toegepas word.

(b) Prosesse waar druk nie toegepas word nie, maar van die uitsetting en inkrimping van lug in die hout by verwarming en afkoeling gebruik gemaak word.

Drukprosesse.

Die bedoeling is om hier slegs 'n baie kort uiteensetting van die prosesse te gee.

Die behandeling van hout word in geslote staal silinders uitgevoer waar druk tot 200 lb. per vierkante duim en temperatuur tot 200°F. toegepas word. Druk word óf deur vloeistof-kragpompe, óf deur saamgeperste lug verkry, terwyl die vloeistof deur middel van stoompype verhit word.

As 'n lugleegte eers in die gelaaide silinder gesuig is, die preserveermiddel dan laat inloop en uiteindelik die druk verhoog word, sal die preserveermiddel forseer word om die selholtes te vul. Dit is bekend

as die volsel-behandeling. As die lading in die silinder hierteenoor aan 'n oorspronklike lugdruk blootgestel is, die preserveermiddel dan teen hierdie druk in forseer en die druk op die vloeistof uiteindelik verhoog word, sal hoofsaaklik die selwande versadig word. Dit is bekend as die leësel-behandeling. Die oorspronklike lugdruk kan in hierdie geval óf dié van die atmosfeer alleen wees, óf kan tot enige voorafbepaalde syfer deur 'n lug-saamperser verhoog word. Die grootste gedeelte van die vloeistof in die selholtes word uitgedruk sodra die druk verminder word en die saamgeperste lug in die hout weer uitsit.

Die keuse tussen die twee behandelingsmetodes hang af van die houtsoort en die doel waarvoor dit gebruik sal word. Vir dieselfde diepte wat die preserveermiddel in die hout indring, word in die geval van die volsel metode veel meer vloeistof as in die geval van die leësel metode absorbeer.

Oor die algemeen word die beste resultate deur drukprosesse verkry. Die installasie wat daarvoor nodig is, is duur en die koste om dit op te rig word slegs geregverdig as op groot skaal gewerk moet word.

Prosesse sonder druk.

By die prosesse waar druk nie toegepas word nie, word op die absorberende eienskappe van die materiaal self gereken om die preserveermiddel in die hout in te trek. Die installasie hiervoor, wat baie goedkoper is as dié vir die drukprosesse, bestaan uit oop vate of tenks met geskikte reëlings vir verhitting van die preserveermiddels in party gevalle.

Weekprosesse.

By weekprosesse wat gewoonlik slegs in die geval van metaalsoutoplossings toegepas word, is die metode om die pale gewoonweg vir 'n paar dae in 'n tenk met preserveermiddel, wat nie verhit word nie, te laat week. Daar moet op gelet word dat die pale vir die hele periode onder die vloeistof is en om verdamping tot 'n minimum te beperk mag die tenks met deksels toegemaak word. Die enigste nodige installasie is 'n oop tenk wat groot genoeg is om die materiaal wat behandel moet word te bevat. Indien 'n beesdip op die plaas beskikbaar is behoort dit vir die doel heeltemal geskik te wees.

Die hoeveelheid preserveermiddel wat absorbeer word, en die diepte wat dit in die hout indring, hang van die houtsoort af. In die geval van dennehout word 'n voldoende absorpsie gewoonlik in twee dae verkry, maar eucalyptus-hout het 'n enigsins langer periode nodig.

Ooptenkproses.

Die naam van hierdie proses is afgelei van die aard van die installasie wat gebruik word en bestaan uit 'n ooptenk met geriewe vir verhitting. Waar stoom beskikbaar is word die preserveermiddel deur middel van stoompype verhit, terwyl in die geval van klein plaasinstallasies die verhitting deur middel van 'n oop vuur kan geskied. Die pale word in die ooptenk onder die preserveermiddel, wat dan van 150°F tot 220°F verhit word, geplaas en die maksimum temperatuur moet van 1 tot 4 uur standhoudend bly. Die pale kan nou óf in die tenk gelaat word om weer tot die temperatuur van die lug af te koel, óf kan uitgehaal word en onmiddellik in 'n twede tenk met koue preserveermiddel oorgeplaas word om vir 'n paar uur daarin af te koel.

Die beginsel waarvan gebruik gemaak word is dat die lug in die selholtes gedurende die warm periode uitsit en gedeeltelike ontsnap. Wat

oorbly krimp by afkoeling in en trek die preserveermiddel dan in die hout in. 'n Borolkraan of 'n geskikte driepoot met katrolstel word gewoonlik oor die tenk opgerig om die neerlaat en uithaal van die pale te vergemaklik.

Foto No. 4 toon 'n oop staal-tenk waarvan die werklike afmetings by die grotte van die pale moet pas. So'n tenk word gewoonlik van sagte staalplaat gemaak en die nate kan óf vasgeklink óf gegaslas word. Hoekyster ribbe wat bepaalde afstande van mekaar af oor die lengte van die tenk geplaas word dien as versterking. Dit word verhit deur middel van stoompype van 1 duim deursnee wat vir die hele lengte langs die bodem gaan. Die pype gaan deur sagte staal stawe en die gewig van die pale rus op die boonste kant hiervan, waardeur verhoed word dat die pype beskadig word. 'n Stoomklep word aangebring om van die gekondenseerde water in die stoompype ontslae te raak.

'n Tenk van hierdie beskrywing is geskik as 'n blywende installasie waar stoom beskikbaar is. Eenvoudiger toerusting wat vir plaasgebruik geskik is word hieronder beskryf.

PRESERVEER-INSTALLASIES OP DIE PLAAS.

Die kapitaalkoste wat in verband met die bou van 'n installasie vir die preservering van hout op 'n plaas ekonomies geregverdig is, hang af van die hoeveelheid hout wat behandel moet word. Hierdie hoeveelheid is gewoonlik betreklik klein sodat die koste van so'n installasie ook in verhouding gering moet wees. Die installasie moet ook so ingerig wees dat die kreosoot daarin veilig oor 'n oop vuur verhit kan word. Alhoewel kreosoot ontvlambaar is, kan brandgevaar tot 'n minimum beperk word deur versigtig te werk te gaan en te verhoed dat dit in die vuur oorkook of uitspat as die pale ingesit word.

Verskillende plaasinstallasies is reeds ontwerp. 'n Algemene metode is om 'n neëntig-gelling drom te gebruik en dit oor 'n baksteen vuurmaakplek te plaas met 'n stuk skoorsteenpyp om die vuur te laat trek. Een van die beste metodes om hierdie tipe installasie te bou is om die ongeveer 3 voet 6 duim hoë drom vir twee-derdes van sy lengte in die grond te laat, waardeur die hantering van die pale vergemaklik word en die verhitting ook baie veilig en ekonomies uitgevoer kan word. Figuur 1 toon die besonderhede vir die bou van hierdie installasie aan.

'n Neëntig gelling drom is geskik om kort pale van ongeveer 6 voet volle lengte te behandel. Die een helfte van die paal word eers behandel, waarna die paal omgedraai word om ook die ander helfte te behandel. Inplaas van die pale om te draai en die hele lengte te behandel, kan goeie beskerming verkry word deur alleen die dikente heeltemal te behandel en die res van die paal slegs in die warm kreosoot te doop. Die kwesbaarste gedeelte van 'n paal is dié gedeelte wat in die grond geplant word en daarom moet hierdie gedeelte behoorlik behandel word.

Dit is beter om die installasie onder die dak van 'n skuur met oop sye op te rig, omdat dit sal toelaat dat die werk onder enige weersomstandighede verrig kan word, en ook verhoed dat reënwater in die drom val of water in die put sal loop.

Om lang pale te behandel moet 'n horisontale oop tenk gebruik word en die grootte daarvan sal van die afmetings van die pale wat behandel moet word afhang.

Baie bevredigende dienste is van die installasie wat in figuur 2 aangegee word, verkry. Die tenk kan van No. 14 dikte plat sinkplaat

gemaak word en die nate kan gegaslas word. Die tenk kan dan, soos in die figuur aangetoon, tussen steenmure ingebou word. Die stene moet styf teen die kante geplaas word, sodat die vlamme op die onderste gebuigde gedeelte van die tenk gehou word. Die tenk moet aan beide ente en ook in die middel ondersteun word deur steenmure wat by die vorm van die onderste gedeelte van die tenk pas. Die gereedskap moet vir beskerming teen reent onder 'n afdak geplaas word, of as dit nie moontlik is nie, kan 'n paar los sinkplate beskikbaar gehou word om dit gedurende reënweer toe te maak.

WERKING VAN DIE PLAASINSTALLASIE.

Die preserveermiddel in die tenk moet tot 'n temperatuur van 150°F tot 220°F verwarm word. Terwyl dit warm word, moet die pale in die tenk geplaas word en deur middel van geskikte gewigte soos beton-blokke, yster stawe, ens. onder die oppervlakte van die vloeistof gehou word. 'n Termometer word gebruik om die temperatuur vas te stel en die preserveermiddel moet volgens soort en dikte van die pale van een tot vier uur op die maksimum temperatuur gehou word. Die vuur moet dan weggeneem word en die preserveermiddel met die pale nog daarin moet toegelaat word om tot ongeveer die temperatuur van die lug af te koel. Aangesien die grootste hoeveelheid preserveermiddel gedurende die afkoelingsperiode absorbeer word en die oppervlakte van die vloeistof in die tenk dus sal sak, moet daarop gelet word dat die pale nie te gou uitgehaal word nie en dat hulle gedurende die hele periode deur die vloeistof bedek bly.

Dit is beter om net een groep pale per dag te behandel. Vul die tenk in die oggend met pale, verhit dit tot die vereiste temperatuur en laat dit dan gedurende die nag afkoel. Die volgende oggend kan die pale uitgehaal word en dieselfde proses met 'n ander groep pale herhaal word.

Die hoeveelheid preserveermiddel wat deur die hout absorbeer behoort te word moet, soos voorheen reeds vermeld, minstens 'n half gelling per kubieke voet bedra. Dit kan nagegaan word deur 'n paar monsterpale voor en na behandeling te weeg. Die volume van die pale kan volgens hul lengte en gemiddelde deursnee bereken word.

Dit kan ook gebeur dat die absorpsie in die geval van bogenoemde metode, veral in die geval van jong dennepale, oormatig is, d.w.s. meer as die maksimum van een gelling of 10 lb. per kubieke voet, en dit sal as gevolg hê dat die behandeling onnodig duur uitkom. Die hoeveelheid preserveermiddel wat absorbeer sal word kan verminder word deur 'n laer maksimum temperatuur te neem, of om die tyd wat die vloeistof op die maksimum temperatuur gehou moet word te verkort.

'n Stuk van ongeveer een voet kan uit die middel van 'n paal gesaag en dan met 'n byl middeldeur gekloof word om vas te stel of die preserveermiddel deur die hout getrek het.

As moeilikheid ondervind word om bevredigende resultate met eucalyptus- en dennepale te verkry, kan die oorsaak wees dat die pale te nat was of die bas nie behoorlik afgemaak was nie; dat die temperatuur van die preserveermiddel nie hoog genoeg gekry is nie, of die maksimum temperatuur nie lank genoeg stand gehou het nie; of dat die pale voordat die vloeistof koud was uitgehaal is.

Om die pale makliker in die tenk to laai en na behandeling weer daaruit te haal, kan 'n katrolstel, soos in foto No. 5 aangetoon, gebruik word. 'n Trekketting word gebruik om die pale in 'n bondel te bind

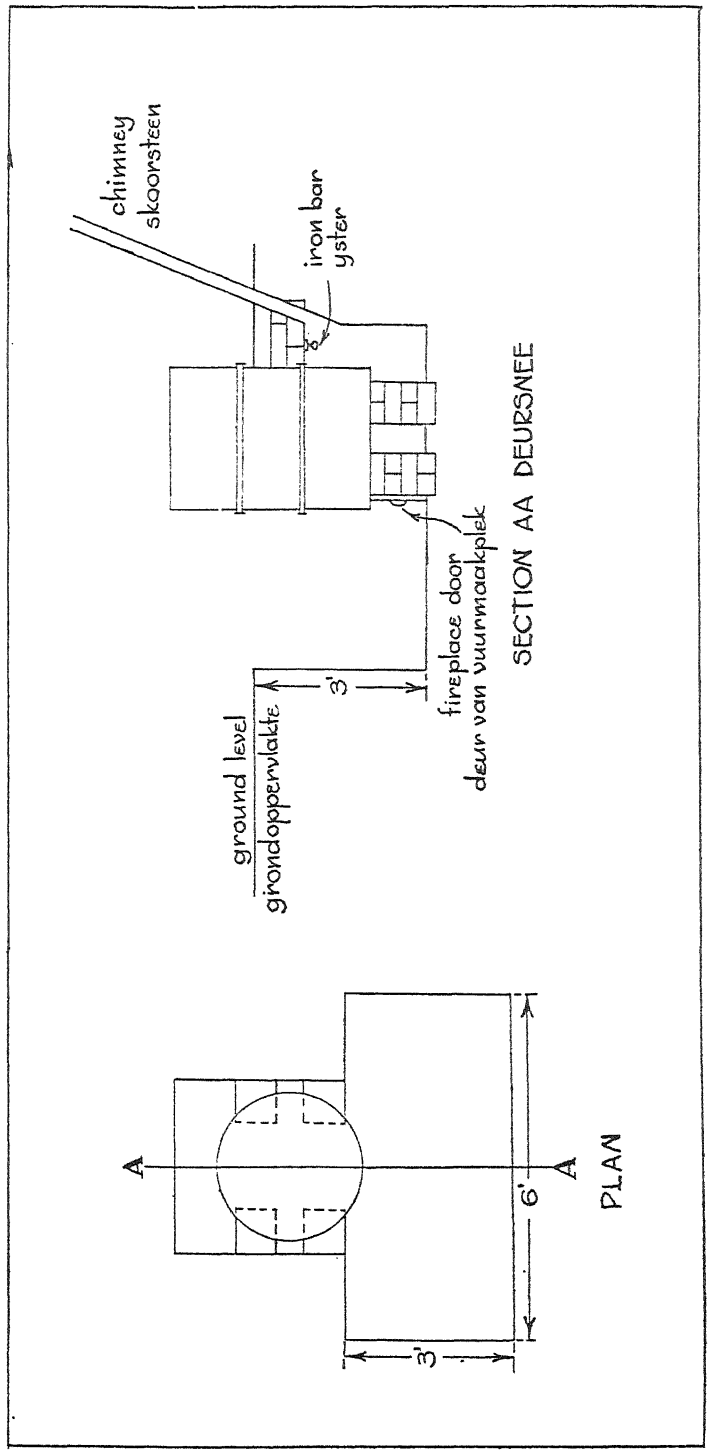


FIG. 1.—Neëntig-gelling drom waarin heiningpale behandel kan word.

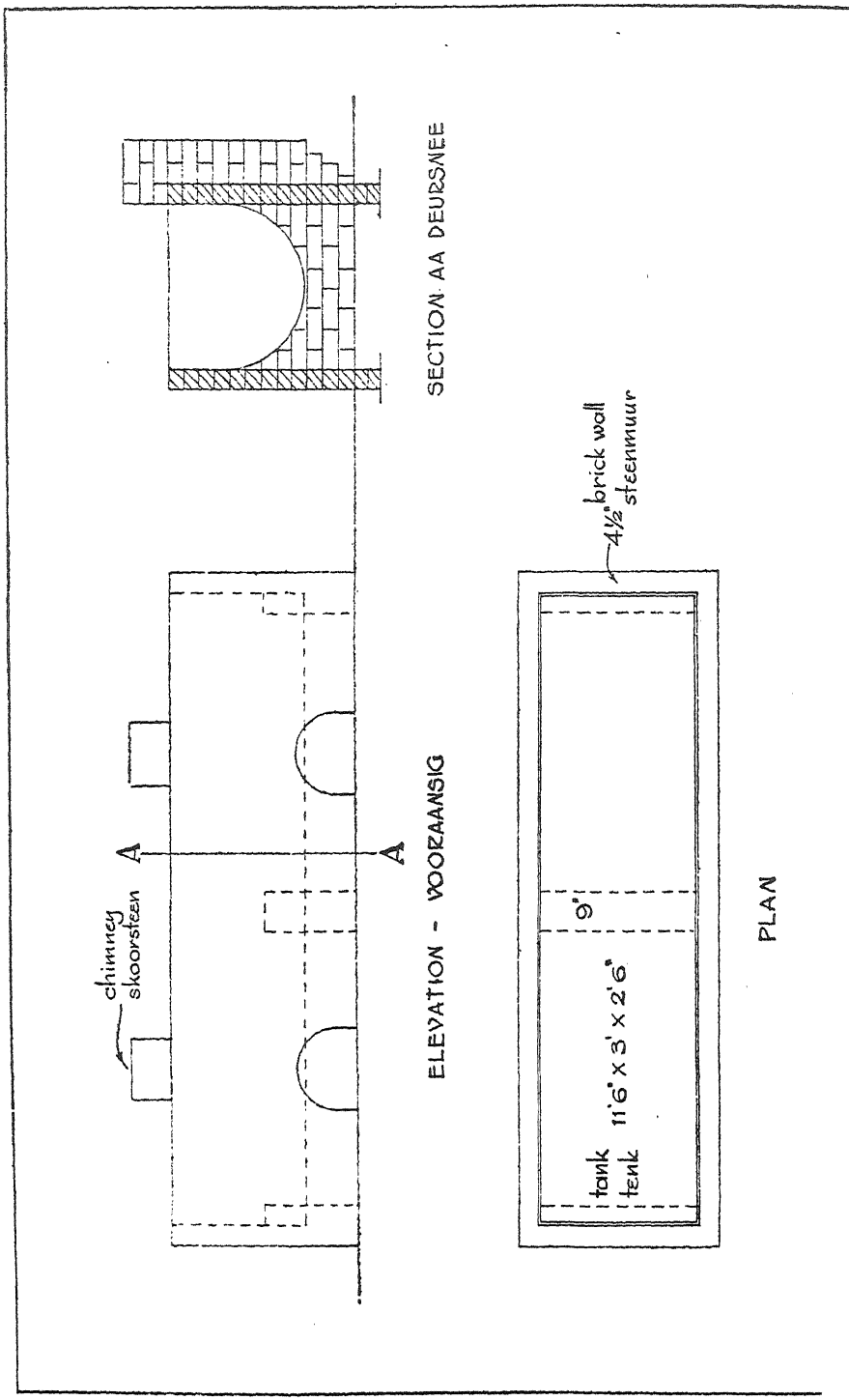

chimney
skoorsteen
A
A
ELEVATION - VOORAANSIG
SECTION AA DEURSNEE
4½" brick wall
steenmuur
9'
tank
tenk
11'6" x 3' x 2'6"
PLAN

FIG. ii.—Oop-tenk vir plaasgebruik.



FOTO 1.—Werf by die Bosprodukte-Inrigting waar pale gestapel word om te droog.

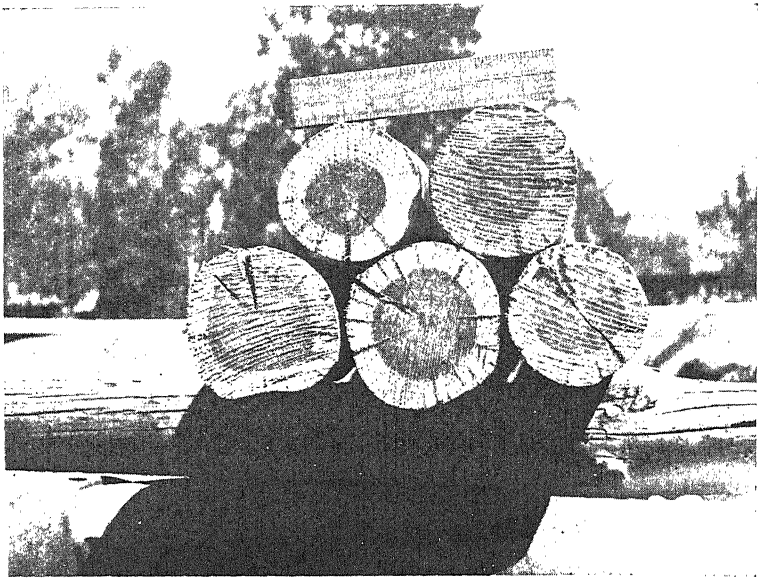


FOTO 2.—Dwarssnitte van pale wat die teenstelling tussen kern- en saphout aantoon.

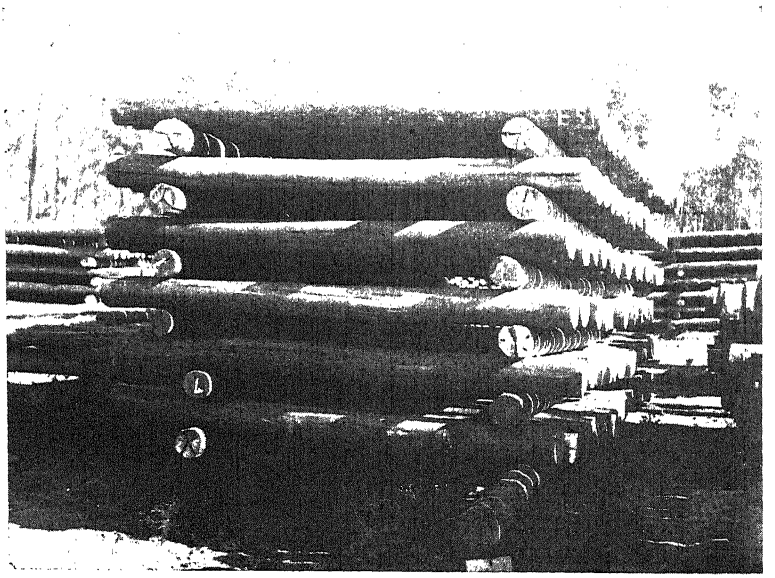


FOTO 3.—Regte manier om pale te stapel vir lugdroging.

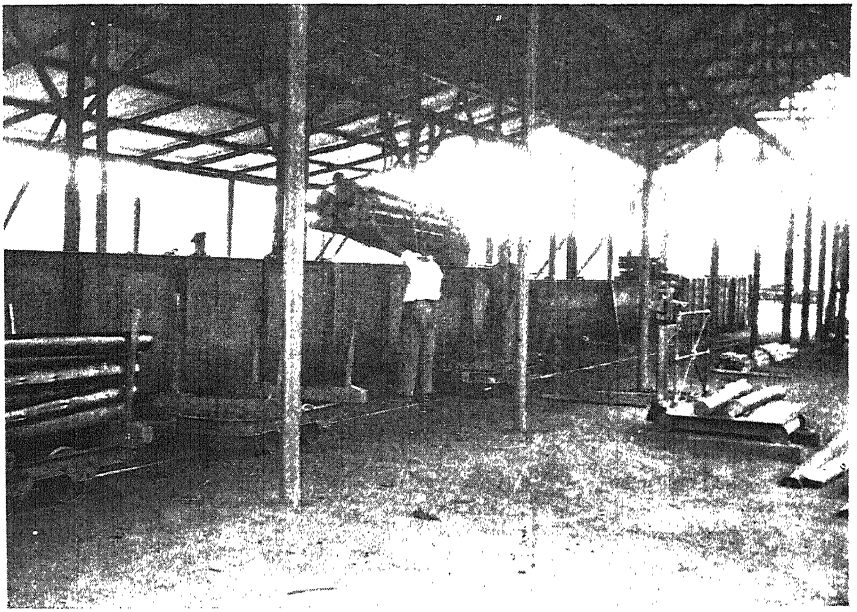


FOTO 4.—Ooptenk-behandeling by die Bosprodukte-Inrigting. Links na regs: 36 en 24 voet staal-tenke en 'n 28 voet houttenk. Die lading word met behulp van 'n borolkraan uitgehaal. Regs, 'n skaal om monsterpale te weeg. Trollies op voorgrond.

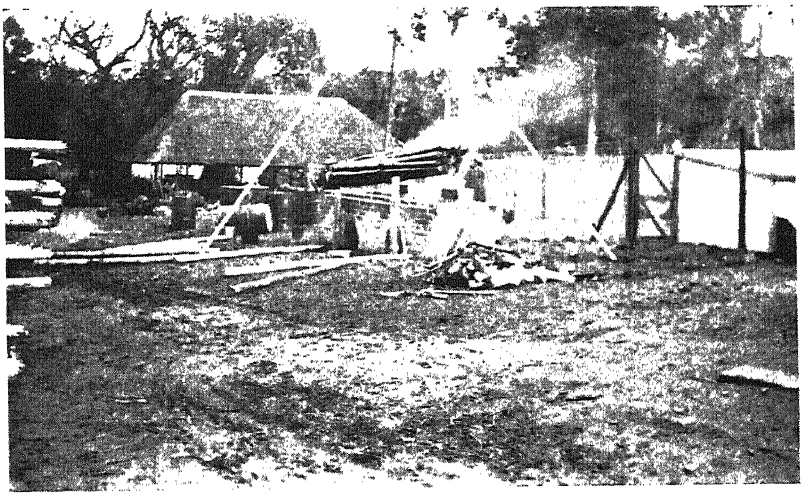


FOTO 5.—'n Plaas-tenk vir die behandeling van pale word met behulp van katrolstel gelaai.

en word gedurende die behandeling net laat skiet en nie afgehaal nie. Om die lading pale uit te haal word die trekketting eenvoudig net weer aan die katrol gehak en die pale uit die preserveermiddel gelig. As die pale uitgehaal word moet dit eers vir minstens 'n halfuur oor die tenk hang sodat die preserveermiddel wat aan die oppervlakte van die pale kleef terug in die tenk kan drup.

VII. Duursaamheid van Onbehandelde Hout.

Soos ons reeds gesien het, is hout onderhewig aan aanvalle deur sekere vernietigende faktore en as hierdie faktore blywend afgeweer kan word, sal die hout byna ewigdurend wees. Sekere soorte hout besit natuurlike eienskappe waardeur hulle sulke faktore tot 'n groot mate kan weerstaan en dit word dan beweer dat hulle 'n natuurlike duursaamheid besit. Duursaamheid is in elk geval afhanklik van die mate waartoe die omstandighede vir die bedrywigheid van swamme, rysmiere, houtkewers, ens. gunstig is en die mate van intensiteit waarmee hierdie invloede die natuurlike weerstand van die hout trag te breek.

Saphout van geen boomsoort is duursaam nie. Hierteenoor variëer duursaamheid van die kernhout aanmerklik volgens soorte. Sedert 1921 is proewe in verband met die natuurlike duursaamheid van die mees algemene inheemse en uitheemse bome uitgevoer, en die resultate hiervan word in tabelle I en II weergee. Kernhout van dié soorte wat aanvalle van rysmiere en verrotting vir 'n periode van ses jaar en langer weerstaan het, word as duursaam beskou, terwyl al die ander as nie-duursaam geag word.

TABEL I.

Inheemse Soorte.

Botaniese naam	Gewone naam
Duursaam.	
Acacia pallens	Knoppiesdoring
Faurea Macnaughtonii	Terblans
Ptaeroxylon obliquum	Nieshout
Pterocarpus angolensis	Kiaat
Pygeum africanum	Rooistinkhout
Spirostachys africanus	Tambootie
Strychnos Henningsii	Hardepeer
Widdringtonia juniperoides	Clanwilliam Seder
Nie-Duursaam.	
Adina Galpini	Matumi
Albizzia gummifera	Platkroon
Albizzia versicolor	Umvanghaas
Apodytes dimidiata	Witpeer
Bersama Stayneri	Bersama
Brachyleana sp.	Vaalbos
Burkea africana	Wildesering
Buxus Macowani	Buig-my-nie
Calodendron capensis	Wildekastaaing
Canthium obovatum	———
Cassine croceum	Saffraan

INHEEMSE SOORTE.

Botaniese naam	Gewone naam
NIE-DUURSAAM.	
Celtis Kraussiana	Camdeboo Stinkhout
Combretum Krausii	Rooiblad
Croton sylvaticus	Croton
Cryptocarya transvaalensis	Wildekweper
Cryptocarya vaccinifolia	———
Cunonia capensis	Rooi-els
Curtisia faginea	Asgaai
Diospyros mespiliformis	Jakhalsbessie
Ekebergia capensis	Essenhout
Fagara capensis	Perdepram
Gonioma kamassi	Kamassi
Ilex mitis	Without
Kiggelaria africana	Wildeperske
Kirkia acuminata	Witsering
Lachnopylis floribunda	Vlier
Milletia caffra	Umzimbeet
Ochna arborea	Rooihout
Ocotea bullata	Swartstinkhout
Olea laurifolia	Swartysterhout
Olinia cymosa	Hardepeer
Platylophus trifoliatus	Witels
Podocarpus sp.	Geelhout
Pterocelastrus tricuspidatus	Kershout
Rapanea melanophleos	Boekenhout
Royena lucida	Swartbas
Sclerocarya caffra	Maroela
Scolopia Mundtii	Rooipeer
Scolopia Zeyheri	———
Trichelia emetica	———
Trema bracteolata	Pigeon wood
Vepris lanceolata	Witysterhout
Virgilia capensis	Keur
Xymalos monospora	Lemoenhout

TABEL II.

UITHEEMSE SOORTE.

DUURSAAM.	
Eucalyptus Blakelyi	Eucalyptus polyanthemos
,, citriodora	,, rostrata
,, paniculata	,, sideroxylon
,, piperita	,, tereticornis
NIE-DUURSAAM.	
Acacia melanoxylon	Eucalyptus microcorys
,, mollissima	,, obliqua
Araucaria Cookii	,, ovata
Callitris robusta	,, numerosa
Castanea sativa	,, pilularis

UITHEEMSE SOORTE.

NIE-DUURSAAM.

Casuarina Cunninghamiana
Cedrela odorata
Cedrela toona
Cedrus deodara
Cinnamomum camphora
Cryptomeria japonica
Cupressus lusitanica
,, sempervirens
,, torulosa
Eucalyptus altior
,, botryoides
,, cornuta
,, diversicolor
,, eugenioides
,, fastigata
,, gigantea
,, globulus
,, gomphocephala
,, grandis
,, Macarthuri
,, macrorrhyncha
,, maculata
,, Maideni
Eucalyptus radiata
,, regnans
,, resinifera
,, robusta
,, saligna
,, Sieberiana
,, viminalis
,, yarraensis
Grevillea robusta
Jacaranda mimosaefolia
Melia azedarach
Pinus canariensis
,, halepensis
,, insignis
,, longifolia
,, patula
,, pinaster
,, taeda
,, teocote
Populus canescens
Quercus pedunculata
Syncarpia laurifolia

VIII. DUURSAAMHEID VAN BEHANDELDE HOUT.

Die duursaamheid van hout, wat met preserveermiddels behandel is, word deur die volgende faktore bepaal:—

1. Die geskiktheid van die preserveermiddel, veral wat sy beskermende en blywende eienskappe betref.
2. Die hoeveelheid preserveermiddel wat in die hout aanwesig is. Hoe dieper 'n bepaalde hoeveelheid preserveermiddel deur die hout trek hoe meer effektief sal die behandeling wees. Alle houtsoorte is vir behandeling met preserveermiddel nie ewe vatbaar nie en die duursaamheid van die behandelde hout is dus indirek afhanklik van die soort.

   Onder origens gelyke omstandighede is die absorberende vermoë van hout tot 'n groot mate van sy digtheid, d.w.s. die relatiewe volume van die selholtes wat met preserveermiddel geval kan word, afhanklik. Die hout van swaar eucalyptus-soorte sal dus nie soveel preserveermiddel as die ligte dennesoorte opneem nie. Dit is gevind dat die kernhout van eucalyptus- en ander loofhoutsoorte sowel as beide die kernhout en saphout van sipres-soorte, as gevolg van natuurlike eienaardighede, nie vir behandeling met preserveermiddels vatbaar is nie.
3. Die omstandighede waaronder die hout gebruik word, in soverre dit die bedrywighede van die skadelike faktore en die bestendigheid van die preserveermiddel in die hout beinvloed.

Resultate van dienstoetse het aangetoon dat die waarskynlike leeftyd van pale wat in sinkkloriede behandel en in grond waarin geen rysmiere voorkom nie geplaas is, onder gemiddelde Suid-Afrikaanse omstandighede van 6 tot 12 jaar is. Indien arseenoksiede by die sinkkloriede gevoeg word, sal dit die geskiktheid van die behandeling teen rysmiere vergroot en 'n dergelyke dienstyd kan dan ook in 'n streek waar rysmiere voorkom verwag word.

Indien hout wat met metaalsoute behandel is nie aan die opelug of aan aanvalle van rysmiere blootgestel word nie, soos byvoorbeeld in die geval van kappe, onderbalke, ens., behou die hout die preserveermiddel feitlik onbepaald en dit word vir alle praktiese doeleindes ewigdurend.

Dienstoetse met pale wat in kreosoot of mengsels van kreosoot en ru-olie behandel is, toon dat die pale na 15 jaar nog onbeskadig is. Volgens resultate wat in ander lande verkry is, kan van hout wat behoorlik met kreosoot behandel is 'n leeftyd van 20 en meer jare verwag word onder die ongunstigste omstandighede.

IX. Beskerming van Binne-Houtwerk.

Die voggehalte van behoorlik beleëgemaakte binne-houtwerk is gewoonlik benede die grens wat vir die bestaan van houtverrottende swamme nodig is en sulke hout is gevolglik nie vatbaar vir sulke vernietigende faktore nie. Hout is egter tot 'n sekere mate higroskopies en het die neiging om vogtigheid uit die lug op te neem wanneer die lugvogtigheid vermeerder en dit ook weer gedurende droë weer af te gee. Hierdie variasie in voggehalte van die hout gaan gepaard met ooreenstemmende swel en krimp daarvan, wat weer trek, barste, verwering, ens. kan veroorsaak. Beskerming word hierteen tot 'n sekere mate gebied met sulke middels soos verf, olie, vernis en was wat trag om die beweging van waterdamp te vertraag. Die gebruik hiervan word vir alle soorte binne-houtwerk aanbeveel. Nie een van hierdie middels is egter instaat om die vogtigheid heeltemal uit te hou nie.

Dit gebeur dikwels in die geval van huisraad, ornamente en toebehore dat die saphout deur larwes van houtkewers aangeval word. Aangesien dit gewoonlik nie moontlik is om artikels van hierdie aard met preserveermiddels te behandel nie, besorg die beskerming daarvan moeilikheid. As die skade nie te groot is nie, is die beste middel om 'n oplossing van gelyke dele parafien en terpentyn in al die vlug-gate te spuit. Dit kan met 'n groot hipodermiese spuit, waarvan die naald deur 'n gomlastiek prop gesteek is sodat die punt ongeveer eenagste duim uitsteek, gedoen word. Die naald word dan in die gaatjie gesteek sodat die gomlastiek styf teen die hout druk en soveel vloeistof moontlik word dan daarin forseer.

Die moontlikheid vir 'n aanval deur houtkewers word aanmerklik verminder as die hout deeglik met sulke stowwe soos vernis of politoer bedek word. Sulke bedekkings is egter magteloos om hierdie soort beskadiging te verhoed as die larwes reeds in die hout aanwesig is.

X. Ekonomie van Houtpreservering.

As hout wat nie duursaam is nie en wat in blywende bouwerk gebruik moet word, met 'n preserveermiddel behandel word waardeur die duursaamheid daarvan aanmerklik verhoog is, sal die behandeling gewoonlik 'n besparing meebring. Indien die gemiddelde leeftyd en

prys van behandelde en nie-behandelde hout op die plek van gebruik bekend is, kan die relatiewe jaarlikse koste van elk deur middel van die volgende formule bereken word : —

$$A = \frac{P(1 + r)^n r}{(1 + r)^n - 1}$$

Waar A = Jaarlikste koste.
P = Bedrag van oorspronklike belegging.
r = Die rentekoers in desimale-syfers.
n = Die gemiddelde leeftyd van die hout.

Dit is byvoorbeeld bepaal dat in Suid-Afrika die gemiddelde leeftyd van 'n onbehandelde paal ongeveer drie jaar is en op die plek ongeveer 1/- per kubieke voet kos. As die rentekoers teen 5 persent geneem word bedra die jaarlikse onderhoudskoste volgens bogenoemde formule 4.2d.

'n Dergelyke paal wat met kreosoot behandel is kos op die plek ongeveer 2/6 per kubieke voet en het 'n gemiddelde leeftyd van ongeveer 20 jaar. Die jaarlikse onderhoudskoste in hierdie geval bedra 2.4d. en toon dus 'n aanmerklike besparing.

Daar die leeftye van behandelde en onbehandelde hout en die prys van onbehandelde hout bekend is, kan die verbruiker bereken hoeveel hy op behandeling kan uitgee om behandelde hout inplaas van onbehandelde hout teen dieselfde koste gebruik. As die syfers van die vorige paragrawe geneem word, word die bedrag wat vir kreosoot-behandelde hout betaal kan word as 4/3 per kubieke voet aangegee.

Die minimum leeftyd van kreosoot-behandelde hout teen 2/6 per kubieke voet, wat net so goedkoop sal wees as onbehandelde hout teen 1/- per kubieke voet, word volgens bogenoemde formule op 9 jaar bereken.

As hout gebruik word waar slegs 'n kort leeftyd vereis word is daar natuurlik geen voordeel in preservering nie, en om natuurlik duursame hout te preserveer beteken gewoonlik ook geen besparing nie. Preservering kan dit egter moontlik maak om 'n natuurlik duursame hout deur 'n minderwaardige nie-duursame behandelde hout met 'n leeftyd wat dieselfde en selfs groter is, te vervang. Behalwe die werklike onderhoudskoste is daar ander faktore wat in aanmerking geneem behoort te word. Deur die leeftyd van hout te verleng en die gebruik van 'n geringer kwalitieit materiaal moontlik te maak, dra die preserveringsprosesse by tot die bewaring van houtvoorrade. Waar houtpreservering nie toegepas word nie is duursaamheid van hout van groot praktiese belang en word baie houtsoorte as minderwaardig bestempel hoofsaaklik omdat hulle nie duursaam is nie.

Wat die keuse van soorte vir bebossingsdoeleindes betref, word Bosbestuur nie deur duursaamheid as 'n faktor wat in oorweging geneem moet word, beinvloed nie, mits die hout vir preservering vatbaar is.

ELECTRIC MOISTURE-IN-TIMBER METER.

By M. H. SCOTT

(Senior Forest Products Officer, Division of Forestry)

AS THE necessity and importance of the proper seasoning of wood has become more generally appreciated and a greater number of specifications now contain moisture content clauses, it has become most desirable to have some rapid and convenient means of testing consignments of timber. This need has resulted in the last decade or so in the development of electric moisture-in-timber meters. These instruments are to-day extensively used overseas but it is only in the last few years that they have been introduced into South Africa, and it is accordingly felt that a few notes on their operation, accuracy and limitations might be of interest.

There are some ten or twelve types of electric moisture meters in common use but the underlying principle on which they operate is essentially the same: direct or indirect measurement of the resistance offered by timber to the passage of an electric current.

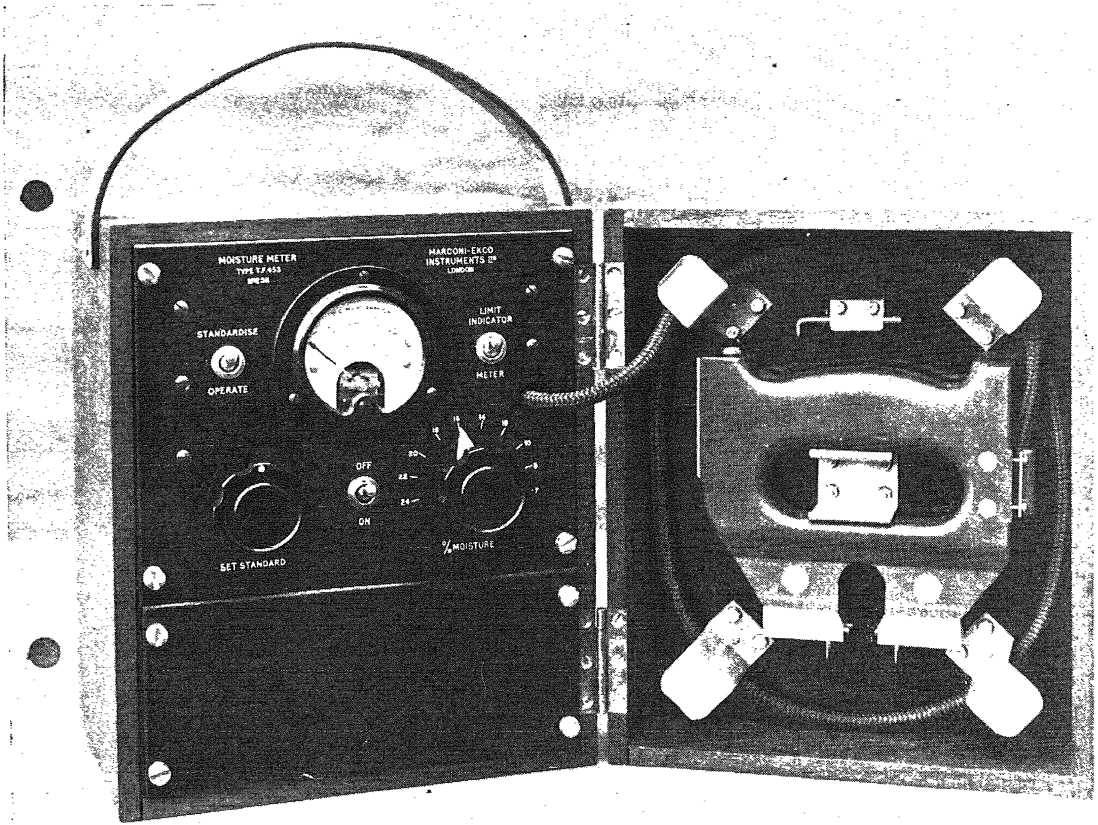
Whereas in some instruments a direct reading of the moisture content is given on a galvanometer scale, in others the beats in an earphone or the leakage through a condenser are timed by means of a stop watch and the corresponding moisture content readings taken from a chart supplied with the meters.

Current to operate the meters may be obtained from a magneto generator built into the instrument, from batteries, or from supply mains, according to the type used.

Most instruments consist of two main parts, the meter proper containing the valves, condenser switches and other apparatus, and the electrodes which are for convenience attached to a handle or clamp connected to the meter by sufficiently long cables to allow of flexibility. Contact with the wood surface is made by means of positive and negative needles or plate electrodes. Clamps may be used to force the needles into the boards or to press the plates into close contact with the surface. Needles penetrate the surface in two places to a depth of about ¼in. on one side or on opposite sides of the board. Other instruments rely on hand pressure only in each case, which is quite satisfactory with soft or moderately hard woods. If needles should be blunted or bent they can usually be very easily replaced.

Moisture Meters may weigh anything from 8 to 25 lbs. and cost from £25 to £55 each.

The method of operation is very simple and any worker of ordinary intelligence can learn to handle the apparatus in an hour or so. Once the instruments are set readings take from half to two minutes each to complete. All it is necessary to do is to make contact between the electrodes and the test piece and record the reaction on the meter which may take the form of the swing of a galvanometer needle or



Electric moisture-in-timber meter.

a number of flashes or beats per minute. Instruments may also be set to show a light as soon as a specified moisture content is exceeded. This facilitates the sorting out of all timber containing moisture in excess of that desired.

The advantages of the electric moisture meter over the normal gravimetric method are rapidity of determination, elimination of scales and ovens for weighing and drying discs, and of errors in the calculations required under the latter. Moisture contents may be obtained in thin dimensions without the necessity of cutting or boring into the boards to be tested, and tests may be made anywhere in the yard or shop provided the test piece is sufficiently accessible.

The advantages must not however be considered apart from the limitations of the instruments. To begin with the range of moisture content over which the meter operates is limited to between about 5 and 25 per cent. This does not permit determinations on green timber. Correction figures have to be used for different species and for different thicknesses of the same species. Wet cores in material over about 1¾in. thick are not detected and thus in timber with moisture gradients readings may be considerably lower than the actual moisture content. Surface coatings may affect the readings as may also wood above normal temperatures.

Most makers guarantee for their machines determinations not more than one per cent. above and below the actual moisture contents, but this has been found to be the case only when the moisture content is very evenly distributed or in testing material not exceeding 1½in. in thickness.

An interesting test was made in this connection. Two small samples of *Pinus patula* 4½in. x 3in. x ½in. of known even moisture content were clamped together side by side between the electrodes in a meter having surface electrodes, with a piece of tin foil placed between them to ensure a good contact. The reading on this inch thick sample reflected a 7.4 per cent. moisture content. A third sample of the same size of approximately 25 per cent. moisture content, was then placed between the two dry pieces and the three pieces clamped between the electrodes with metal foil between the faces of the wood as before. The whole made a sample 1½in. thick. The reading on the meter recorded now 7.5 per cent. moisture content, showing that the resistance offered by the dry exterior pieces, only, was measured and not the average of the composite block.

Wetting the surface of the boards to be tested under the electrode, just sufficiently to ensure a good contact, has been found to improve the accuracy with surface contacts where there is a moisture gradient.

Four types of meters have been examined at the Forest Products Institute and two have been very fully tested. In practice allowing for correction figures determinations 1.5 per cent. to 2 per cent. above or below the actual moisture content has been found to be as much as can be expected for wood up to 2 inches in thickness; and for thicker material there may be greater differences. The error in thick timber may be minimised by determining the actual distribution of moisture throughout the thickness and averaging it. For this purpose determinations are made on a number of lesser thicknesses cut from the original board. This method, of course, involves considerable handling of stock, which is one of the disadvantages of the gravimetric method

that the introduction of electric meters was hoped to minimise.

So far as individual machines are concerned there does not seem to be a great deal to choose between them. In some it would appear that convenience and simplicity of operation have been considered of more importance than precision.

Electric moisture meters have proved a boon to many timber merchants and are no doubt quite accurate enough for commercial purposes. To ensure that timber, in addition to being merely dry, is really well seasoned and free of stress, stress sections are cut from sample boards and their behaviour studied. As the response of these sections to release occupies an appreciable time, the advantage of quick moisture determination by meter is largely lost.

In seasoning from the green condition drying samples are often used, and the use of the meter here becomes superfluous, and in any case moisture at all in excess of 25 per cent. cannot be determined by it. In circumstances such as the foregoing, and where great precision is required for scientific purposes, the use of moisture meters is limited.

AN IMPROVISED POLE TESTING MACHINE.

By JOHN M. TURNBULL and P. M. D. KROGH

(Forest Products Institute, Pretoria West)

IN ORDER to ascertain the transverse breaking strain of telephone and power transmission poles of various tree species, a pole testing appliance was recently installed at the Forest Products Institute, Pretoria West. The appliance comprises, (a) a concrete straining block, to which the butts of poles under test may be strapped in a horizontal position; (b) a composite steel cable for attachment to the pole tips to cause deflection in a horizontal plane; (c) a suspended hand winch to take the strain causing the deflection; and (d) a machine for registering the applied stress at deflections of fixed interval, up to failure.

The straining block is rectangular in shape, with an open centre to ensure firmness at minimum expenditure of material. Its total height is 6ft. 5in., of which 2ft. 5in. is above ground. Its outside dimensions are 6ft. 5in. by 4ft., and inside, 3ft. by 2ft. Sunk and anchored deep in the long wall furthest removed from the winch are five vertical pairs of ¾in. iron bolts protruding horizontally ten inches beyond its face. Between the two lines of bolts the face of the block is recessed to accommodate the pole butts, which may then be clamped into position by screwing down over them a series of iron saddles, one for each pair of bolts. A better arrangement, under which renewal of broken or badly bent bolts without interference with the wall of the block might have been facilitated, would have been provision of iron sleeves for insertion of the bolts.

The apertures of the saddles, themselves, as will be seen from figure 2 are sleeved to ensure a straight thrust, and thus avoid bending of the bolt ends. At the corner of the block, which acts as a fulcrum for the stress, a wooden bearing block is inserted to reduce the harshness of contact at the equivalent of ground level.

One section of the composite cable is attached by means of a split iron collar to the tip of the pole being tested. The collar is adjustable by bolts to tips of any diameter. The cable next hooks on to a two-sheaved pulley block and tackle connected with the suspended hand winch. This device enables one man to apply a stress of up to 2,000 pounds through the winch to the pole tip. The winch, in turn, is connected by a short length of cable to the fixed head of a 30,000 pound Riehle static bending test machine, the stresses imposed by it being transmitted into a vertical direction by means of a ball-bearing pulley erected directly under the head, and secured by a flexible steel stay anchored in a concrete block let into the ground on the other side of the machine. The total distance between the tips of poles being tested and the weigh machine is 49 feet. A considerable length of cable is desirable as, although at the commencement of each test, the pull is truly perpendicular, the direction deviates slightly as deflection of the

pole tip increases, and the longer the attachment the lower will the angular displacement be.

In normal use, the movable head of the test machine on which the stress is recorded is made to descend and depress small clear wooden specimens at the centre of their unsupported span until they break, the stress thus applied being transmitted to a weigh table on which a platform supporting the specimen rests. By harnessing the pole testing cable to the fixed head after passing over the direction changing pulley, the stress imposed by the winch is likewise transmitted to the weigh table. The complete device and certain of its more important parts are illustrated in figures 3 to 6.

The straining block is duplicated to accommodate poles of two different spans. This discloses a weak feature of the equipment. Each of these somewhat elaborate blocks provides for testing over one fixed span only. Any variation in span would involve an angular displacement in pull, whereas values for perpendicular stresses are required. These might of course be computed from the resultant stresses, but this is not desirable. The aim in timber testing should be reduction of calculation as much as possible. The difficulty might have been obviated by installation of a strutted iron straining block travelling on rails embedded in the top of a concrete foundation long enough to allow for a utility range of span.

The equipment was required in an emergency, and the rather primitive arrangement described had to suffice. Trouble was anticipated in the control of rate of loading, which is dependent entirely on the human element. It has been found, however, that the deflection per minute, with an intelligent native at the winch, is not very erratic. It averages about five inches per minute for most species, and such variations as do occur do not appear to have any significant effect. The reliability of the values yielded may be judged by comparing those for poles of varying diameters with theoretical adjustments of the average to the same diameter equivalents.

Transverse strength varies directly and linearly with the loaded width of a member, and directly with the square of its depth. In a member of square section, therefore, it will vary directly with the cube of either dimension, and for circular section, as in poles, with the cube of the diameter. Given constant absolute taper therefore, the breaking strain for a pole of any diameter, d_1, at its weakest point may be converted to the equivalent value for one of different diameter, d_2, by multiplying the test value by the factor d_2^3/d_1^3. Theoretically the weakest point of a pole is where its diameter is one and a half times the diameter at the loading point, which may be taken, for practical purposes, as equalling the tip diameter. Telephone poles, even at their butts, rarely attain such diameters, and for purposes of the experiment about to be described, d, accordingly, represents diameter at ground level, computed by applying individual absolute taper of the respective poles to the unsupported span of 14ft. 6in. For instance a 20 foot pole measuring 5.02 inches at its tip and 6.4 inches at its butt will measure 6.02 inches at 14ft. 6in. from its tip.

The experiment referred to above entailed the testing to failure of 49 20-foot untreated *Pinus patula* poles over a span of 14ft. 6in., on the Institute's equipment. Diameters and breaking strains for individual poles are shown in table I, and the plotting of breaking strains against the

TABLE I.

DIAMETERS AND BREAKING STRAINS OF 49 *Pinus Patula* TELEPHONE POLES

Test No.	Actual diameters. inches.		Taper ins.		Diameter as at ground level		Actual breaking strain lb.
	Tip	Butt	Actual	As at ground level	Basic	Cubed	
1	5½	6¾	1¼	.905	6.41	264	835
2	5½	6½	1	.725	6.23	252	930
3	5	6⅜	1⅜	1.000	6.00	216	990
4	5⅛	6	⅞	.635	5.76	191	980
5	5	6⅛	1⅛	.815	5.82	197	845
6	5½	6½	1	.725	6.23	252	1120
7	5	6⅛	1⅛	.815	5.82	197	920
8	5	6¼	1¼	.905	5.91	207	1060
9	5¾	6⅞	1⅛	.815	6.57	284	1290
10	5½	6¾	1¼	.905	6.41	264	1310
11	4⅝	6¾	2⅛	1.540	6.17	235	835
12	5½	6¼	¾	.545	6.05	222	1025
13	5¾	6½	¾	.545	6.30	250	1300
14	4⅞	6½	1⅝	1.180	6.06	223	920
15	5½	6¾	1¼	.905	6.41	264	1090
16	5	6⅛	1⅛	.815	5.82	197	1050
17	5⅜	6⅝	1¼	.905	6.28	248	1170
18	5¼	6¼	1	.725	5.98	214	1270
19	5⅜	7⅛	1½	1.087	6.71	303	1290
20	5½	6⅞	1⅜	1.000	6.50	276	1330
21	5	6⅝	1⅝	1.180	6.18	237	680
22	5¾	6⅝	⅞	.635	6.39	262	950
23	5¼	6½	1¼	.905	6.16	234	1150
24	5½	6⅝	1⅛	.815	6.32	253	1150
25	5	6½	1½	1.087	6.09	226	825
26	5⅛	6½	1⅜	1.000	6.13	231	710
27	4⅝	6⅞	2¼	1.640	6.27	247	680
28	4¾	6¼	1½	1.087	5.84	200	670
29	4½	6½	2	1.450	5.95	211	850
30	4¾	6¼	1½	1.087	5.84	200	900
31	4⅝	6¼	1⅝	1.180	5.81	196	585
32	4¾	6	1¼	.905	5.66	182	760
33	4¾	6¾	2	1.450	6.20	239	910
34	4¾	6	1¼	.905	5.66	182	785
35	4¾	6	1¼	.905	5.66	182	600
36	4½	6	1½	1.087	5.59	175	700
37	5	6¾	1¾	1.270	6.27	247	875
38	4⅞	6¼	1⅜	1.000	5.88	204	940
39	4⅝	6¾	1⅞	1.360	6.24	244	1050
40	4¾	6¾	2	1.450	6.20	239	780
41	4½	6⅛	1⅝	1.180	5.68	184	705
42	4⅞	6½	1⅝	1.180	6.06	223	880
43	4⅜	5⅞	1¼	.905	5.53	170	810
44	4¾	5¾	1	.725	5.48	165	780
45	5	6	1	.725	5.73	189	900
46	5	6⅛	1⅛	.815	5.82	197	800
47	4¾	6	1¼	.905	5.66	182	1045
48	4¾	6½	1½	1.087	5.84	200	1120
49	4¾	5⅞	1⅛	.815	5.57	173	725
Aver.	5.02	6.40	1.38	1.000	6.02	219	929

cubes of the respective diameters, in figure 1. Although absolute taper of individual poles varies, the graph adjusts values to a constant average taper, so that values read off the line are comparable in this respect.

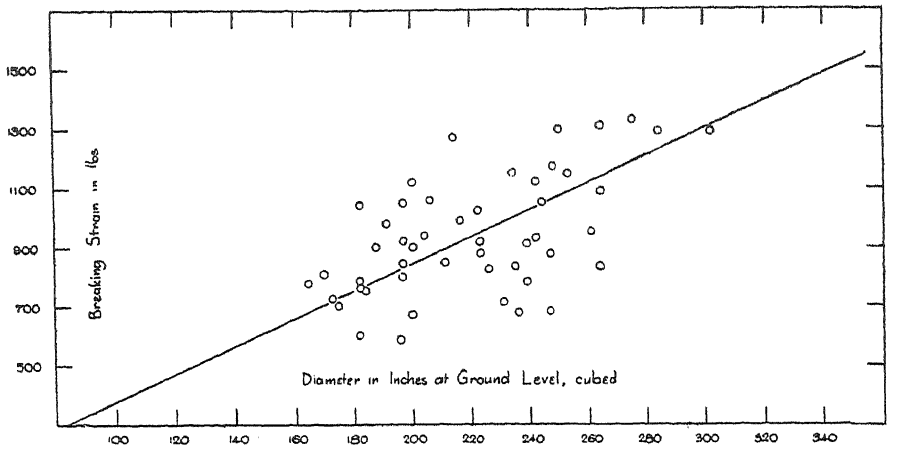


FIG. 1.—Relationship between breaking strain and diameter, based on tests on 49 *Pinus patula* poles.

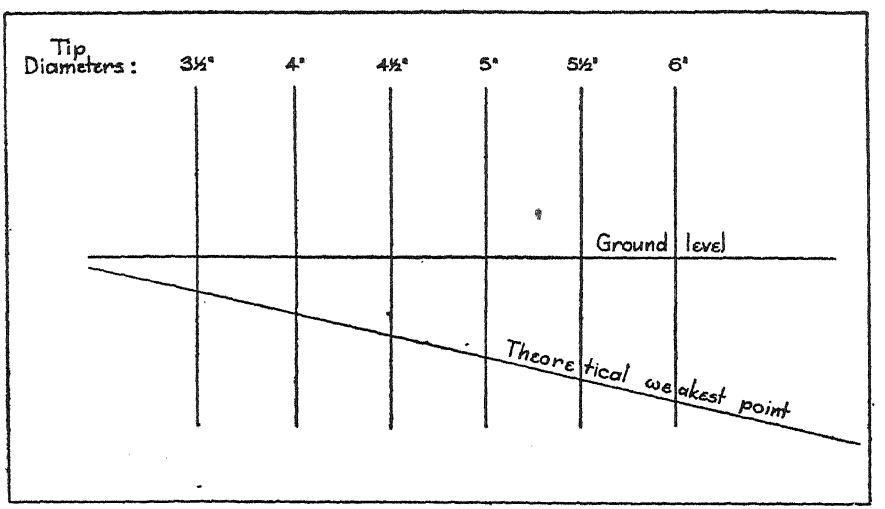


FIG. 2.—Diagrammatic representation of divergence of line of weakest point in poles of progressively increasing diameter relative to ground line.

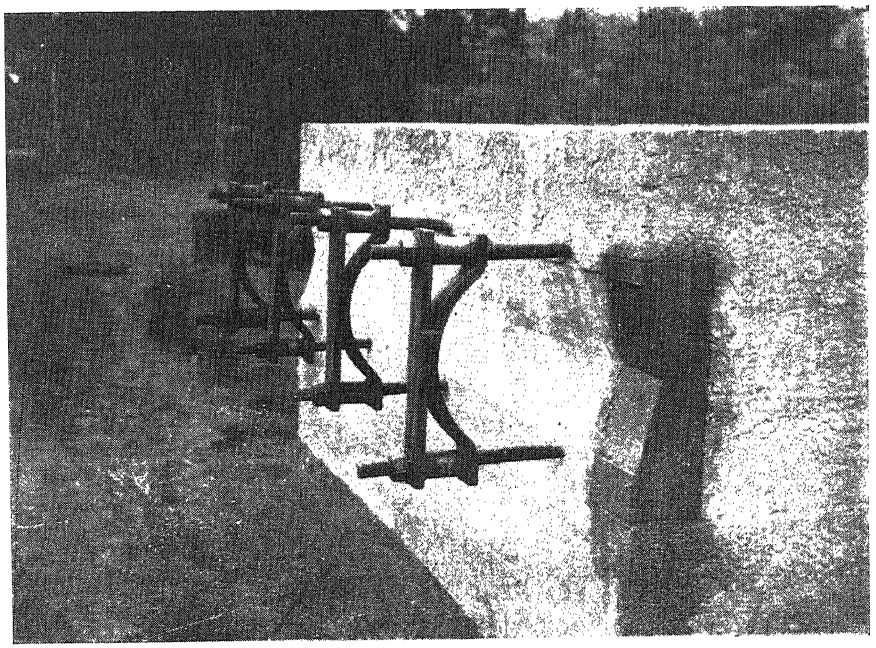


FIG. 3.—Straining block and clamps.

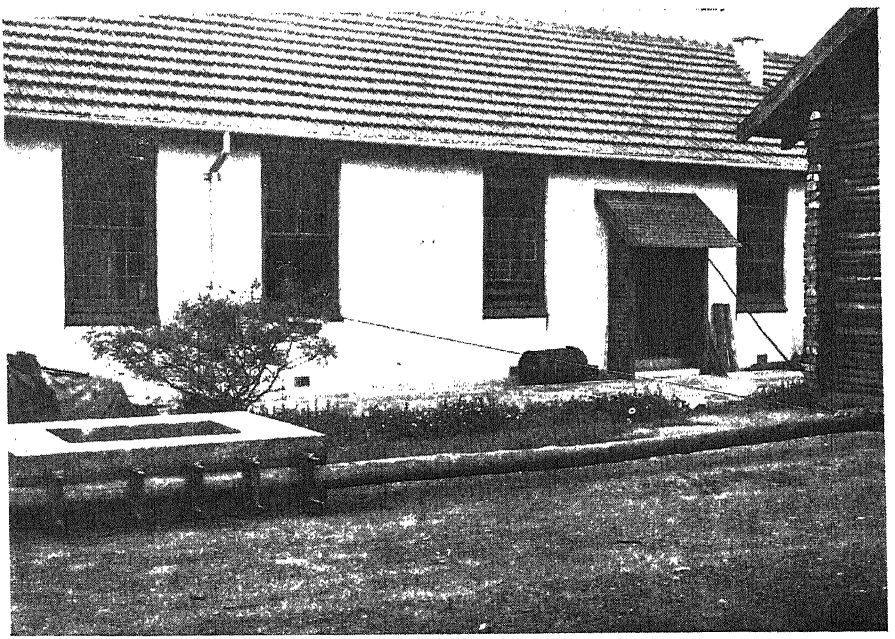


FIG. 4.—Pole clamped in position with deflection cable attached.

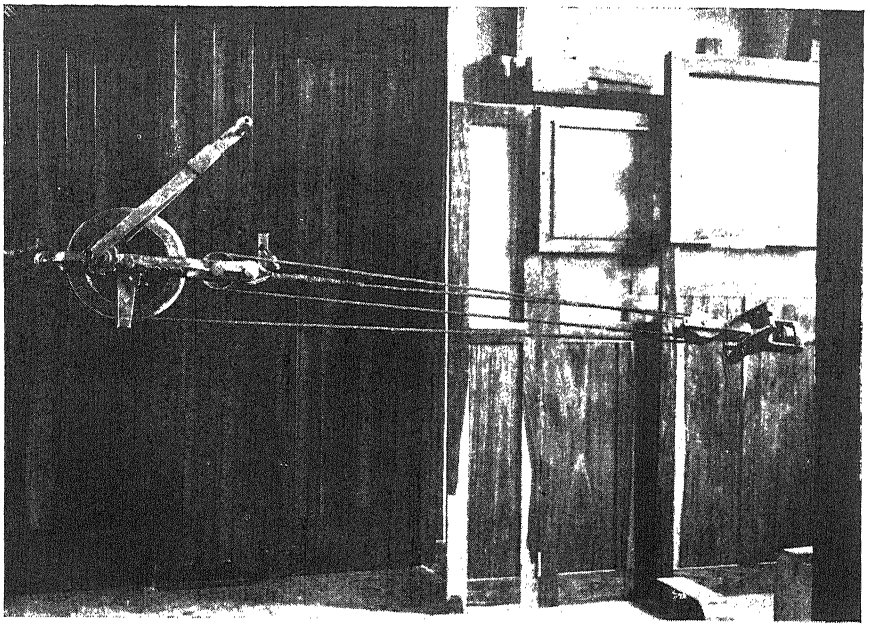


FIG. 5.—Hand winch and block and tackle connecting deflection cable and weigh table.

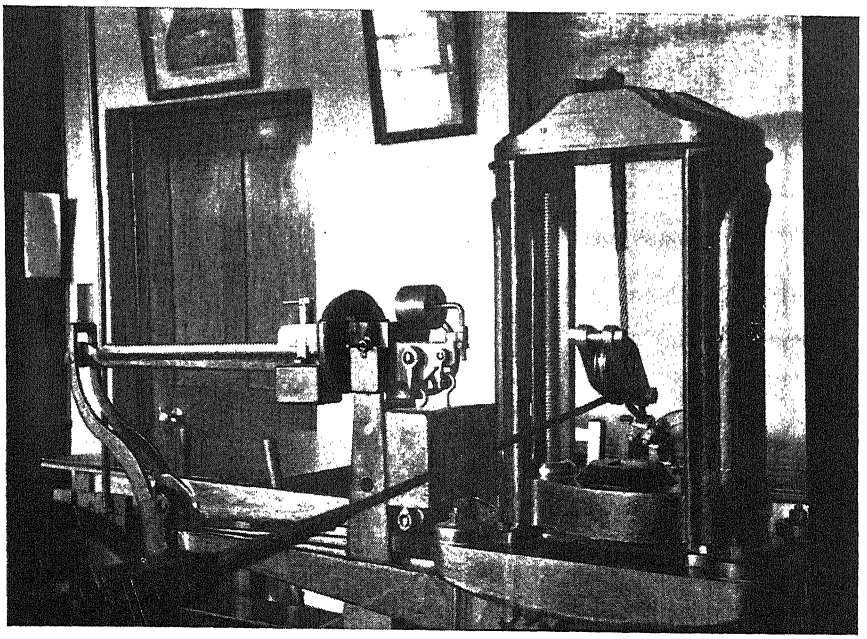


FIG. 6.—Static bending test machine. Weigh table on right. Recording arm on left.

TABLE II.

COMPARISON OF THEORETICAL AND EMPIRICAL BREAKING STRAINS

Tip	Diameter. Inches. Ground level. Basic	Ground level. Cubed	Breaking strain in lb. as obtained from Fig. 1	Formula	% Variation	Distance between theoretical weakest point and ground level. Ft.
3½	4.5	91.3	350	388	9.8	11.1
4	5.0	125.0	510	530	3.8	14.7
4½	5.5	167.0	690	708	2.5	18.3
5	6.0	216.0	915	917	.2	22.0
5½	6.5	276.0	1190	1170	1.7	25.7
6	7.0	343.0	1500	1460	2.7	39.2

Values read off against tip equivalents of 3½, 4, 4½, 5, 5½, and 6 inches, that is, empirically obtained values adjusted by the graph to comparable taper, are reflected in table 2, together with the theoretical adjustments of the mean value of all 49 poles to these respective tip diameters. In respect of the higher diameters the correspondence is remarkably close. It will be noticed, however, that the ratio between the theoretical and empirical values varies inversely with the tip diameter concerned. This is as might be expected, for as indicated in the final column of table 2, and in figure 2, given constant taper, the distance between ground level and the theoretical weakest point varies directly with tip diameter, so that the lower the tip diameter, the lower will the plotted breaking strain be relative to the theoretical value.

THE BEGINNING OF FORESTRY EDUCATION IN SOUTH AFRICA.

THE accompanying photograph is of interest in that it depicts the first class of the first school of forestry to be established in South Africa or, for that matter, in the Southern hemisphere.

In 1905, shortly after his appointment as the first Chief Conservator of Forests for the Cape Colony, Mr. J. Storr Lister obtained the sanction of the Government for the establishment of a South African School of Forestry, a step that he and others had previously strongly urged. At that time there were in South Africa only half a dozen academically trained foresters including Mr. (later "Sir") D. E. Hutchins, who was a graduate of the French State forestry school at Nancy. The others, being already in the Cape service, had been sent by the Government, or had gone at their own expense, for training at Cooper's Hill. One other, Mr. G. A. Wilmot was at that time just finishing at Yale.

It was the difficulty and expense in those days connected with overseas training, together with the growing need for qualified officers that led to the establishment of the South African school. According to a Government notice issued at the time in this connection the South African School of Forestry was established by the Government of the Cape Colony "for the scientific training of forest officers and for research in South African forestry." The aim of the school was "to provide a thorough course of instruction in forestry with special reference to South African conditions."

The school in some measure received financial support from other South African governments, including Rhodesia and Basutoland. It was open to nominees of the different Governments who wished to have men already in their services trained in forestry, as well as to candidates from abroad for appointment on a competitive basis to such services.

Hutchins, at this time Conservator of Forests for the Western Conservancy, took charge of the school and lectured in forestry subjects. On his retirement a year or two later he was succeeded by J. S. Henkel. Wilmot acted as assistant lecturer from the start.

The school was centred at Tokai, but the students took their science subjects at the South African College, where they had the benefit of lectures from such eminent scientists as Professor H. H. Pearson, Dr. D. Hahn, and Professor (later "Sir") Carruthers Beattie.

In 1911, after having served a very useful purpose in training several batches of men who served in the professional grades, the school was closed down, and was succeeded at Tokai by one for the training of foresters in the lower grades. For the higher grades the system of nominating men for training overseas was thenceforth adopted, and continued until 1932, when the Chair of Forestry at Stellenbosch University was instituted.

After 33 years the tale of those associated with the first class of the original school is as follows:—



SOUTH AFRICAN SCHOOL OF FORESTRY TOKAI 1906.

H. J. Sankey. Vernon.
A. E. Gower. A. J. O'Connor. Vernon. L. E. Taylor. A. Clark.
G. E. Wilmot. J. S. Henkel. E. J. O'Connor. J. D. Keet.

D. E. HUTCHINS, after his retirement from the Cape service continued in harness in an advisory capacity in East Africa and Australia. Before his death he was knighted for his services in the cause of forestry.

J. S. HENKEL continued in occupation of senior posts in the Cape and Union services, but left ultimately to take charge of forestry work in Southern Rhodesia. On retirement he went to Natal where he is still actively engaged in scientific pursuits. The degree of Doctor of Science was conferred on him by the Natal University.

G. A. WILMOT left the service, but continued in the profession in a private capacity. He was for many years consulting forester to the Lion Match Company. He died in 1936 from the effects of an accident which occurred in the execution of his duties.

J. D. KEET is now Director of Forestry for the Union, and A. J. O'CONNOR his deputy.

H. J. SANKEY was the nominee of the Orange River Colony government, but after Union he left to take up a post in Nigeria, and is now farming in East Africa.

L. E. TAYLOR was the nominee of the Transvaal government. After Union he left, and is now a lecturer, flower cultivator, and collector in British Columbia.

The other students, the VERNON brothers, who came from England to attend the course, A. CLARKE, and E. J. O'CONNOR finally took up work outside the forestry profession. The two last-mentioned are still in South Africa.

Associated with the first class were C. E. LANE-POOLE and H. RYAN, both graduates of Nancy. They came to South Africa and attended the local school for post graduate work in South African and sub-tropical forestry. Lane-Poole was engaged by the Transvaal government, but after Union left to take up an appointment in Sierra Leone, and later one in Australia, where he is now Inspector-General of Forests for the Commonwealth. Ryan continued in the Cape and Union services, and retired only recently on pension.

The photograph includes also A. E. GOWER, Superintendant of Tokai Plantation at the time, and a staunch pioneer of forestry in South Africa.

A.J.O'C.

A METHOD OF STACKING POLES IN RESTRICTED YARDS.

By P. J. A. LOSEBY

THE stacking yards maintained in connection with wood preservation plants are used for the purpose of seasoning poles to the required degree of dryness before treatment and also for the carrying of adequate stocks. With a view to obtaining proper drying, it is necessary to raise the stacks at least nine inches clear of the ground and to separate the layers of poles by means of cross stickers of a thickness equal to at least half the diameter at the thick end of the poles in the stack. It is obvious that any increase in foundation height or sticker thickness will increase the amount of waste space in the stack and consequently decrease the number of poles which can be stacked in any given area. It is recommended, therefore, that the figures mentioned above should not be exceeded in order to ensure the most economical use of the stacking yard consistent with the proper drying of the poles.

The most economical height to which a stack of heavy poles may be built by hand is just above shoulder height, or about five foot six inches. Any increase above this height slows down the speed of handling and requires the employment of a greater number of boys in the span. With the rapid increase in the scale of operations at treating plants in this country, however, stacking space within a convenient radius of the plant is becoming restricted, and recourse must be had to the building of higher stacks irrespective of additional cost. The method to be described has been put into operation at the Forest Products Institute, Pretoria West, with good results.

The method may best be described as the building of one stack on top of another, the top stack being reduced in width so as to leave a "step" on which the boys may work and to provide a spot on which to place the poles after the first lift. The stack is first built up to shoulder height in the usual way. Boys then climb on to the top and the poles in the top layer for a width of eight foot from the front of the stack are moved to the back to begin a new layer. A new lot of poles is lifted on to this eight-foot step, and these are again moved to the back to complete the new layer. These operations are repeated and successive layers of poles are built up while the full width of the step is maintained. With heavy poles, it is not recommended that an over-all height of eleven foot be exceeded on account of instability when the stack is built any higher. The accompanying photograph shows a stack nearing completion. The six poles on the step (marked with a pointer) will be lifted to the top layer which is not quite finished.

About forty per cent. more poles may be stacked in a given space by the application of this method.



Method of stacking poles in restricted yard.

CROSS-SECTION DIMENSIONAL ADJUSTMENT OF SUBSTITUTE TIMBERS.

By JOHN M. TURNBULL.

WOOD of species closely associated with a particular use is not always available, or in specific instances, not desirable. Where bending strength has an important bearing on design, and standard dimensions have been closely calculated, it is essential that, for constant span, any departure in unit strength in the substitute from that of standard material be allowed for by adjustment of the cross-sectional dimensions of members. A significant part of design is the ratio existing between width and depth of members, and, if this ratio is to be maintained, the adjustment becomes complicated by the fact that strength does not vary proportionately with both width and depth. It varies directly and linearly with width, and directly with the square of the depth. In spite of this, the adjustment is not so complicated as might be supposed. Unit strength, or S, is the ratio between load at failure, L, and the dimensions raised to the powers mentioned above: thus, width, w, and depth squared, d^2. This might be expressed mathematically as follows:—

$$S \text{ varies as } \frac{L}{wd^2}$$

Any alteration in cross-sectional area in which the ratio between width and depth remains unaltered, involves application of the same factor, x, to both dimensions. Such altered cross-section may be expressed as wdx^2 and in relation to its resistance to load, as $wx(dx)^2$ or wd^2x^3. Now, if materials of different unit strength, S, in the case of standard material, and, S′, for the substitute, are required to support the same load, the following two identities are involved:—

$$\frac{L}{wd^2} = S$$

$$\frac{L}{wd^2\,x^3} = S'$$

By expressing left and right terms respectively in the two identities as ratios, the following equation results:—

$$\frac{L/wd^2}{L/wd^2x^3} = \frac{S}{S'}$$

$$\text{or } x^3 = S/S'$$

$$\text{whence } x = \sqrt[3]{S/S'}$$

In other words, to support over the same span the same calculated maximum transverse load as standard material, the width and depth of substitute members must be multiplied by the cube root of the ratio between the unit strengths of the standard and substitute materials.

EXAMPLE.

On a certain job it has been customary to use Baltic deal rails 3in. wide and 5in. deep. The contractor is now authorised, subject to appropriate amendment of design, to use South African grown *Pinus insignis* of similar grade. Assuming bearing span and width-depth ratio of cross-section are to remain unchanged, what cross-sectional dimensions are permissible?

Good average values for modulus of rupture for imported deal and South African grown *Pinus insignis* are 10,000 and 13,000 lb. respectively. Substituting these values for S and S' in the formula, the following expression is obtained:—

$$\sqrt[3]{\frac{10}{13}}$$

which equals .916. Applying this factor to the standard dimensions of 5in. and 3in., the dimensions for *Pinus insignis* should be 4.575 and 2.745 inches respectively or, to the nearest eighth inch, 4⅝ and 2¾.



PHOTO No. 1.—*Phoenix reclinata* just behind Littoral dune on Kentani coast.



PHOTO No. 2.—Termite mound, *Phoenix reclinata* and broad leaved species on Kentani coast.

CORRESPONDENCE
KORRESPONDENSIE

PLANT SUCCESSION ON THE TRANSKEIAN COAST.

To the EDITOR.

Sir,

The accompanying photographs may be of interest to readers of the Journal. Both were taken near Qolora on the Kentani coast, Transkei. No. 1 shows clumps of *Phoenix reclinata* which originate on termite mounds. As the palms develop, conditions favourable to the establishment of broadleaved species are created. In course of time the palms are ousted by the broadleaved species. Photograph No. 2 shows a termite mound, palms and broadleaved species. On the sky-line on right hand side of No. 1 may be seen an almost continuous patch of bush which has become established as described above.

Yours faithfully,

N. L. KING.

Pretoria.
8th August, 1939.

GROWING *EUCALYPTUS SALIGNA*.

To the EDITOR.

Sir,

After four years of practical experience in growing and marketing *Eu. saligna* I feel that I can make at least some general observations on this species. Not until various plantations have been followed through from planting to felling and marketing can really detailed figures be given.

Eu. saligna is generally regarded as one of the fastest growing trees in the world for the first few years of its life. Height growths of 20 ft. per annum are not uncommon, and on favoured sites and on first grade soils with a rainfall of 60 inches and over as in the Duivelskloof Tzaneen area plantations of 5 years old are often sufficiently mature to be felled for mining poles. Of the plantations observed the average annual diameter increment at breast height is one inch with a height growth over the whole rotation of twelve feet per annum. For the first three years of a plantation's life the height growth is comparatively small, averaging 8-10 ft. per annum but with a large diameter increment. The third to fifth years appear to be the period during which the height growth reaches its maximum while the diameter increment falls off.

In the area referred to above a rough guide to maturity for mining purposes can be taken from the planting espacements. If a plantation is planted 6ft. x 6ft., an espacement out of favour until recently owing to the mines' requirements being for larger sizes, the plantation can generally be felled at 6 years, for volume increment appears to fall off from the sixth year onward, and the poles are readily saleable. Similarly

a 7ft. x 7ft. plantation can be felled at 7 years and a 9ft. x 9ft. plantation at 9 years, although in practice plantations of the larger espacements are often felled before this.

To foresters outside South Africa the average annual volume increment of the *Eu. saligna* plantations must seem almost unbelievable. My experience here has proved that an average annual increment of 400 cu. ft. per acre is not uncommon.

In planting pot-holing is not as successful as ploughing and harrowing due to the difficulty of keeping down weed growth during the first 18 months of the plantation's life. Pruning is unnecessary, although the removal of dead branches does facilitate barking and detracts from the damage in case of fire. Thinning for mining timber is not advocated.

Normal losses in any plantation, due to natural causes, appear to be between 20 and 25 per cent., while approximately 5 per cent. of the stools fail to coppice after felling. This latter loss, however, can be largely obviated by leaving two or more stems per stool around the blanks and the practice is recommended particularly to-day, as if necessary, diameters of 2 and 3 inches can be taken out and sold. There is a small market for 2-3 inch laggings.

The tenets of established forestry practice do not always hold for *Eu. saligna*. It is now a fairly general practice among growers to leave suppressed trees standing when a plantation is felled. Contrary to established ideas of the recovery of suppressed trees a suppressed *Eu. saligna* tree will make an amazing recovery and at the end of the first coppice rotation is a dominant, unless, as sometimes happens, it is broken by wind or rain in the first year.

Another practice followed when a plantation has been damaged by wind and rain is to cut injured trees at 9 or 17 ft. from the ground, as the 8 ft. pole is the most readily saleable. In two or three years one or two leading shoots are almost up to the surrounding trees, and in some cases the damaged tree can hardly be distinguished from its companions.

The identification of the true *Eu. saligna* appears to be very difficult for I have had several different species mentioned by botanists for the same plantation. It appears likely that quite a large proportion of so-called *Eu. saligna* plantations are *Eu. grandis* or possibly a *Eu. saligna* x *maculata* hybrid.

In the majority of local plantations the bark comes off the tree in long strips which makes it very easy for the felling contractor but in some, and these plantations can be identified with experience, barking is very difficult as the bark comes off in small patches only. It is these trees which I have tentatively identified as *Eu. grandis* or as mentioned above the *Eu. saligna* x *maculata* hybrid and I am endeavouring to reach some definite conclusion.

The planting policy and the marketing of mining poles are so closely allied that it is impossible to separate the two as the percentage of each diameter class of poles in plantations of varying espacements must be considered and the lack of a settled policy on the part of the mines as to the sizes they will need 6-10 years from now makes it very difficult to recommend any one planting espacement. Hence planting with any one espacement is a gamble. The present requirements of the mines are for poles from 6 ft. x 6 ft. and 7ft. x 7 ft. plantings

but 4-6 years ago the espacements most favoured, as it produced the major quantity of the poles needed at that time, was 9 ft. x 9 ft. The result to-day is that the 9 ft. x 9 ft. plantations are just reaching maturity while the mines' requirements are for the timber produced by 6 ft. x 6 ft. plantations.

The preparation of each year's tenders is generally governed by the timber available for felling during the coming year, i.e. some mines take certain sizes of timber, other mines different sizes again and it is necessary to so arrange one's tenders that all sizes can be disposed of. Where certain tenders are unsuccessful there is a surplus of that class of timber.

Eu. saligna timber can be so treated that it will resemble practically any species on the market to-day. It can be polished to resemble teak and oak among others while timber from younger plantations compares in appearance with matured soft woods. Further investigation into the uses of *Eu. saligna* for fruit and vegetable boxes will be repaid as *Eu. saligna* not over 9 years old and sawn green makes very fine boxwood and is not liable to "blueing" as is *P. Patula.*

An enlightened policy on the part of *Eu. saligna* growers in leaving a percentage of the total trees in each plantation for the production of saw logs will result in giving this country a supply of a timber that can be used for almost any purpose when properly seasoned, and I feel that some Government assistance should be rendered in this matter. This policy of standards does not seem to affect the surrounding coppice.

This is one of the few countries in which there is not rigid state control of all the ramifications of forestry and it is felt that there could be more strict inquiry into the future of a tree which is being so largely planted to-day. Should the mines not wish to take *Eu. saligna* in the same quantities as now, or, a remote probability, should they close down, there would be vast quantities of unwanted timber. Every contingency must be taken into account by foresters who have to plan for coming generations although with the comparatively rapid growth of most exotic species in this country, the future is often forgotten, and only immediate returns considered.

Yours faithfully,

G. L. GUY,
B.Sc. For. (Edin.)

Politsi,
Transvaal.

DESTRUCTION OF NATIVE FORESTS IN NORTHERN ZULULAND.

To the EDITOR.

Sir,

In a notice of your first issue (October, 1938) in the April number of the *Quarterly Journal of Forestry,* the reviewer expresses concern that the greatly increased establishment in the Union's forestry service indicated by Mr. King in his "Historical Sketch of the Development of Forestry in South Africa" has failed to check the heavy destruction

described by Colonel Reitz in another article in the same issue. In case other readers may have similarly confused the domains covered by the two writers, I should like to point out that the native forests of Northern Zululand, referred to by Colonel Reitz, have in the past been excluded entirely from control by the forest service of the Union. As stated in your editorial foreword to Colonel Reitz's article, it was not until last year that regulations appropriate to the conservation of these forests were promulgated by the Native Affairs Department in consultation with the Division of Forestry, and personnel appointed to enforce them.

Yours faithfully,

J. D. KEET,

Director of Forestry.

REVIEWS—RESENSIES

ELEMENTARY FOREST MENSURATION. By *M. R. K. Jerram, M.C.* (London. Thomas Murby & Co., 1939. Pp. viii + 124, Figs. 38. Price 8/6 net).

Jerram has written this book for students who intend taking up forestry as a profession, and also to serve the requirements of practising forest officers. It has come to take the place of Part I, Forest Mensuration of the 5th edition of Schlich's Manual Vol. III, which has now gone out of date and out of print, and as such will fulfil a real need, as the many know who have grown accustomed to run to Schlich in the past.

Forest Mensuration generally is the subject which gives most students trouble. The simple, direct and intelligible way in which Jerram in the book introduces the subject will, I feel sure, help a great deal to expel many of the mensuration bogeys for the student. As a first book on mensuration, therefore, it should receive a warm welcome.

It is rightly called "Elementary Forestry Mensuration" because of the fact that "the author deals very briefly with certain subjects, which, though they may be of fundamental importance to the specialist and research worker, are not, in his opinion, part of the essential equipment of every professional forester." The author, therefore, does not burden the book with some of the more advanced and modern introductions in mensuration such as the use of statistics, alignment charts, graphical methods, and the technique of ring counting. Except for a very simple reference to the use of graphs in an appendix, he refers the advanced reader to other works specially dealing with these special fields and their use in forest mensuration.

The information given in the book is logically arranged, and for each major kind of measurement is given under the headings "definition," "objects of measurement" and "procedure." Important formulæ are conveniently indicated in the text by being serially (numerically or alphabetically) indicated.

A very valuable and interesting chapter in the book is contributed by Mr. R. Bourne, on the Measurement of Forests, dealing briefly with the determination of the productive capacity of site, the growing stock, and the market requirements, for it is realized that in a long time type of investment, as in forestry, working must be planned, and that sound planning is impossible without a knowledge of these factors.

Useful information dealing with bark percentages, multiplying factors for quarter-girth measurement, areas of circles for diameters and circumferences, generally useful tables, etc., tangents of angles and gradients and the use of graphs is contained in seven appendices which close the book.

The publishers and printers also deserve a warm word of praise for putting out this well printed and bound book at a reasonable price.

E.J.N.

TEXTBOOK OF DENDROLOGY, COVERING THE IMPORTANT FOREST TREES OF THE UNITED STATES AND CANADA. By *William M. Harlow* and *Ellwood S. Harrar*. (London. McGraw Hill Publishing Co. Ltd., 1937. XII + 527 pp. 224 figs. 25/- net).

A knowledge of the names of trees, their ranges and habits, and main botanical characteristics is a fundamental requisite in the study of forestry. The subject called dendrology is generally designed to provide for this, the successful study of which demands a thorough knowledge of the fundamentals of nomenclature, classification and identification. With this in mind the book opens with a very excellent introduction which treats these fundamentals in a simple, but effective manner, fully illustrating and explaining the terms generally used in botanical descriptions. Following this the book divides itself into two sections, one dealing with the Gymnosperms and the other with the Angiosperms. These two subdivisions of the Plant Kingdom and such orders as fall in them are very briefly described as to their historical origin and significance and their more outstanding botanical characters and importance. Families and Genera are treated in somewhat greater detail especially as to their botanical features. Tables also are used covering the family and generic characters.

The details of the information given for each of the species in the book are presented under the following headings, viz. : *distinguishing characteristics* which give the most striking characters by which the species is identified; *general description* which includes information of a number of silvical features such as sizes of mature trees, form, site, associates, tolerance, seed production and germination and growth; range; and the botanical features under which the principal characteristics of leaves, flowers, fruits, twigs and bark are included.

This book is richly illustrated with excellent half tone photographs of the outstanding botanical features of the various species, which will undoubtedly help to give more life to the descriptions, and to bring these more realistically before the reader.

The book closes with a glossary of terms used in botanical descriptions, and a list of selected references.

The book is a definite contribution to dendrological literature, and the logical arrangement of the information contained in it, and the method of approach to the subject will help a great deal to make the study of dendrology a realistic one to the student instead of just a cram of taxonomic characteristics.

It forms one of the American Forestry Series of forestry text books.

E. J. N.

LUMBER: ITS MANUFACTURE AND DISTRIBUTION. By *Ralph Clement Bryant*. (New York. John Wiley and Sons, Inc. London. Chapman and Hall Ltd., 1938. Second Edition. XXIV 535 pp., 132 figs., 6in. x 9in. 25/- net).

The First Edition of Professor Bryant's Lumber appeared in 1922 and won the reputation of being the standard text book for students and instructors in lumbering in forest schools. As a result of the numerous changes and developments that have taken place in the subject, during the last two decades, this second edition has resulted,

covering the same general field, and having the same objectives as the first.

The author, however, in addition to showing "the improvements in equipment and manufacture which have been introduced in recent years to keep the industry abreast of modern technological progress," also discusses "the post-war adjustments in the field of lumber distribution which were designed to bring lumber production and distribution into harmony with the new economic era."

This he does in an interesting, intelligent and very clear manner, and gives the reader a most detailed picture not only of the manufacturing plant, machinery, tools, and equipment connected with it, but also of lumber manufacture and lumber markets and marketing.

It closes with an extensive appendix in which are included a bibliography in which the references are arranged under subject headings, a most useful and instructive list of terms used in lumber manufacture and distribution, and many tables giving statistical data on lumber grades, lumber sizes, weights and shrinkage, lumber production in the United States and many other interesting details, and a very full index.

The book contains much that is suggestive for South African readers especially at a time when our plantations are yielding material ready for conversion to lumber.

It worthily carries on the reputation gained by its first edition, and serves as a fitting monument to the memory of the late Professor Bryant.

E.J.N.

PLANT COMPETITION IN FOREST STANDS. By *C. F. Korstian* and *T. S. Coile*. (Duke University School of Forestry Bull. 3 Nov., 1938. 125 pp., 49 tbls., 71 figs.)

On the basis of seven trenched plots and untrenched controls in coniferous and hardwood stands in North Carolina, the work of Korstian and Coile confirms the findings of Fricke, Fabricius, Aaltonen, Toumey and the reviewer, in this field. Observations made during the period 1932-36, in stands varying in age between 9 and 42 years, showed that the removal of root competition within the soil of trenched quadrats, by severing the roots of the surrounding trees, promoted a mesic growth environment relative to the xeric one of the untrenched controls.

This study is of particular interest for, wherever possible, a statistical reduction of the data shows the significance of the conclusions drawn. The authors found that soil moisture and not available nitrogen as found by Romell in Sweden, is the factor which determines tolerance in the closed stands investigated.

The results of this competent work again lay emphasis upon the concept that the growing space allotted per tree in silvicultural thinnings must be inversely proportional to the water-supplying power of the soil.

I.J.C.

ANATOMIE DE LA FEUILLE CHEZ LES PINS MARITIMES, by *V. Fieschi*, and CLASSIFICATION DES PINS MARITIMES, by *V. Fieschi* and *H. Gaussen*. (Published in "Le Bulletin de la Société d'Histoire Naturelle de Toulouse," Vol. XIV, 1932—II.)

The first-mentioned paper consists of an anatomical study of the characteristics of the races (as distinguished by Duff) of *Pinus pinaster* Ait. (P. *maritima* Poir.). The author considers that the Atlantic Race (including the Landes and Portuguese Types) should be regarded as one species, and the Mediterranean Races (consisting of the Maures and Esterel, and Corsican Races) as another, with the Maures and Esterel Race as one variety and the Corsican Race as the other variety of the second species. The basis for these conclusions is the claim that sections cut at the base of the leaf fascicle, within the region of the basal sheath, never have more than two resin canals in the mesophyll (the term is used here to denote the portion of the leaf between the endoderm and hypoderm) in the case of the Atlantic Race, and generally more than two canals in the Mediterranean Races. It is averred that this anatomical distinction is retained when trees of one race are cultivated in a region in which one or other of the remaining races occurs naturally. As an example the Landes Pine which retains the Atlantic characteristics when cultivated at Narbonne, where the indigenous pine is of the Mediterranean type, is cited. No anatomical differences were found between the Maures and Esterel, and Corsican Races, but it is claimed that they can be distinguished by differences in form and habit.

The authors of the second paper adopt the conclusions reached in the first, and proceed to classify the species as follows:

1. *Pinus maritima.* This species has only two resin canals in the mesophyll at the base of the leaf within the region of basal sheath, where stomata are absent from the leaf surface and the resin canals are marginal. It is comprised by the Landes and Portuguese types.

In passing, it is interesting to note that these writers follow Duff in attributing the superior growth of the Portuguese type, in comparison with the Landes type, to more favourable climatic factors, whereas it has been shown in South Africa that the Portuguese strain retains its superiority when both are grown under identical climatic and soil conditions.

2. *Pinus mesogeensis.* In this species there are generally more than two resin canals in the mesophyll at the base of the leaf, within the region of the basal sheath from which stomata are absent. In form it is said to differ from *P. maritima* in having more horizontal branches.

P. mesogeensis is subdivided into two varieties as follows:—

(a) *P. mesogeensis corteensis,* comprising the Corsican type.

(b) *P. mesogeensis provincialis,* comprising the Maures and Esterel type.

These varieties are separated on the basis of differences in form and habit.

Following Duff, the possibility of the existence of further races is recognised (the Italian type being quoted as a possible example), but further study is recommended before the classification of these races can be attempted.

Passing now to the critical examination of the above-mentioned conclusions, it may, in the first place, be observed that the validity of establishing a species on a difference, for which no more can be claimed than that it generally occurs, is open to serious question.

Secondly, since the author of the first paper admits to being totally unacquainted with these races in the field, one may legitimately ask

what precautions were taken to ensure the collection of correctly named material.

Finally, the basic anatomical data themselves do not appear to be of universal application, for it has not proved possible to substantiate them from an examination of locally grown representatives of the various races. The material examined was grown at Tokai and was raised from seed of the following origins: Var (two separate parcels of seed), Alpes Maritimes, Corsica (Vivario), Landes (Mimizan), Gascony, Portugal, and Tuscany (Lucca). Four of these parcels of seed were collected by Duff in person and the remainder by officers attached to various forest services. It was found that, in sections cut from the basal portion of the fasicle, two resin canals predominated in the mesophyll of all races in the region where the individual leaves were just beginning to be differentiated. On the other hand, more than two resin canals predominated in all races when the section was taken at a point where the individual leaves had completely separated from one another. The latter sections were all taken well within the lower half of the basal sheath. The basis for distinguishing between the Atlantic and Mediterranean Races therefore falls away and with it the justification for regarding them as separate species also disappears. The reviewer is therefore of the opinion that the conclusions reached by these authors have no validity whatsoever.

E.K.M.

THINNING, PRUNING AND MANAGEMENT STUDIES ON THE MAIN EXOTIC CONIFERS GROWN IN SOUTH AFRICA, by *I. J. Craib, M.F., Ph.D.* (Science Bulletin No. 196. Department of Agriculture and Forestry, Union of South Africa, 1939.)

This publication deals entirely with the exotic pines in the Government-owned plantations in the Union and has no reference to the management of the considerable areas owned by companies or private individuals.

Part I contains a determination of the volume of coniferous wood available for sale during the next decade from plantations managed under contemporary thinning practice. Thinning regimes for the three most important pines, *P. patula, P. pinaster,* and *P. insignis,* are given together with a number of tables and graphs, which mobilise all the data collected by the Forest Research Section of the Division of Forestry during a period of some years over a wide range of sites and ages. These standard volume and other tables are of particular use to officers of the Division of Forestry and owners of large plantations of conifers in South Africa for the preparation of working plans and determination of yields from thinnings.

Part II gives an analysis of the pruning policy in operation at the time that this part was written (nearly two years ago) followed by detailed pruning schedules, based on this analysis, for *P. patula, P. insignis* and *P. pinaster.* These schedules apply only to stands which have been thinned on the conservative lines practised in the past. Pruning schedules applicable to stands to be established and thinned on the much more drastic lines advocated in Part IV are incorporated in the management schedules contained in that Part. The analysis on which the pruning schedules are based pre-supposes that the rotations tentatively suggested in Part I will be adopted but, as the author points

out earlier, the maximum permissible unpruned core will vary appreciably according to the length of the rotation. Conversely if the diameter of the unpruned core is fixed at a maximum of 5 inches any increase in the length of the rotation will increase the radius of clear timber and, consequently, in such cases more pruning will be justified. The rotations suggested will, however, in all probability be approximately correct for existing Government owned stands.

Part III contains an analysis of anticipated yields and profitability under contemporary thinnings practice and shows that, out of a total anticipated annual yield of 75 million cubic feet from existing stands, 30 million cubic feet will be from 3 to 8 inches in diameter and that 15 million cubic feet of this small diameter wood will be obtained from thinnings. The author also shows that in the case of *P. pinaster* on second and third quality sites profitability is extremely doubtful. The value per cubic foot of logs of small diameter is markedly lower than that of larger logs but the author is, one hopes, unduly pessimistic in saying that the marketability of such logs is doubtful. Some 21 million cubic feet of the estimated annual yield of 30 million cubic feet under 8 inches in diameter is over 5 inches in diameter and it seems reasonable to expect that the bulk of this wood of 5 to 8 inches diameter will, after a few years, be absorbed by the pulp and paper making industry which is being established in the Union and by manufacturers of the small sized fruit box shooks.

Parts IV and V. The subsequent portions of the publication aim at prescribing methods of management which will not only increase the average diameter of the logs produced within given rotations but also the total proportion of the more valuable larger diameter logs and the proportion of knot free lumber.

Very drastic departures from current practice are advocated, the most revolutionary being the adoption of wider initial espacements and heavier thinnings as the quality of the site deteriorates; the extreme case being that of slow growing pines on third quality sites where an initial espacement of 12ft. x 12ft., thinning at 8 to 9 years of age to 120 stems per acre and at 30 years to 60 stems per acre with pruning of 75 stems per acre to 22 feet in 3 stages between the ages of 8 and 20 years, is recommended.

These recommendations are based on all the data collected by the Research Sections of the Division of Forestry. The data are admittedly subject to revision but are sufficient to indicate that the conclusions come to are sound. Modifications will no doubt be necessary as more accurate data become available but adjustments will be quantitative rather than qualitative. Wide initial espacements are not an innovation. Espacements as wide as 20ft. x 20ft. were in use 50 years ago, but, as early pruning was not carried out, the method was condemned because the timber produced was too knotty and very close espacements were adopted.

The principle arguments against wide espacements have been the doubt as to the strength of fast grown timber and the probable excessive knottiness of the wood produced.

The proposed espacements and thinnings will yield logs with not less than 4 rings to the inch and Turnbull (S.A. Jour. Sci. Vol. XXXIII, pp. 653-682 1937) has found that strength is not affected by the rate of growth but is a function of density, that this again is a function

of percentage of summer wood, and that the production of summer wood is consistently proportional to the production of spring wood irrespective of the rate of growth of the tree. The author claims, and is supported by many foresters in the Union, that the strength of the timber produced by the methods he advocates will not be less than that produced under current methods of management. It is obvious that pruning very early in the rotation is essential if knot free timber is to be produced in stands with wide initial espacements and heavy early thinnings.

There is considerable difference in opinion on the effect which grass and other undergrowth will have on very open young stands but all experimental data go to show that the effect of undergrowth persisting in such stands is less detrimental than the suppression exerted by the trees on each other in a stand with completely closed canopy.

The tables giving an analysis of the anticipated yields from stands managed on the lines advocated show, as would be expected, that the estimated total yields per acre will be somewhat lower than in the case of stands managed under contemporary practice, but that the great improvement in size distribution will result in a very considerable increase in value, particularly on third quality sites.

The sketch of the current policy of thinning research given by the author will be of interest to all workers in this field and the detailed data and photographs given for research plots in *P. patula* at Weza are most illuminating.

The use of the table (page 139) showing predominant height over age as affected by site quality will result in a much more accurate assessment of quality for each pine species on a uniform basis for the whole Union than has been the case in the past.

The estimates of probable annual yields of softwoods for the years 1940 to 1980 and of the number of sawmills which will be required to utilize this yield will be of general interest to the timber trade in the Union.

The publication should stimulate great interest—some no doubt antagonistic—among all foresters.

W.E.W.

TIMBER DRYING AND THE BEHAVIOUR OF SEASONED TIMBER IN USE. By *R. A. Bateson, B.A.* (Crosby Lockwood & Son, Ltd. 1938. Pp. xiv + 138. 10s. 6d. net).

The author of this book has had considerable first hand experience of the subjects with which he deals, and is therefore well qualified to write on them. He acknowledges his indebtedness for permission to use data accumulated at the Forest Products Laboratory, Princes Risborough.

The subject matter is dealt with in a simple and readable way, which will appeal to the layman and the professional reader alike. All relevant facts regarding moisture and shrinkage in wood are fully dealt with, and the air-drying of wood is briefly but efficiently handled. The various types of seasoning kiln are clearly described, and the many common problems met with in seasoning adequately dealt with. A welcome chapter is that on 'timber drying and the "small man" ', which is devoted to the problems of firms whose operations are not sufficiently

large to justify installation of kilns.

The author is at pains to point out that seasoning and drying are synonymous terms. This is a matter of definition, but we have always understood that the term dry wood does not signify that the wood is free from stresses, whereas "seasoned" does. The only other criticism that might be offered is the omission in a special section on the avoidance of stains, of any reference to the many efficient anti-stain solutions now on the market.

The illustrations are good, and the book should be a useful addition to the library of anyone interested in the air-drying or kiln-seasoning of timber.

M.H.S.

THE TIMBER AND SAWMILLING INDUSTRIES. Board of Trade and Industries Report No. 245. Government Printer, Pretoria. 1939.

The Acting Minister of Commerce and Industries instructed the Board of Trade and Industries on the 24th October, 1936, to inquire into and report upon the timber and sawmilling industry in the Union.

Throughout 1937 and 1938 whenever time permitted, the members of the Board familiarized themselves with the forest condition generally, and timber production with special reference to the suitability of the woods grown. A great deal of time was devoted to the industry concerned with the conversion of wood in the round log to innumerable products with a view to present and future market requirements.

A number of significant conclusions emerge from the resulting report of which a few are mentioned hereunder. Apart from the indigenous forests which contain mostly slow growing species, the results of afforestation clearly show that both soft and hardwood can be successfully grown in the Union. The total area afforested up to 1936 was over 300,000 acres but it has been estimated that the needs of the country fifty years hence would possibly require 1,900,000 acres. With a view to the acquisition of additional land a comprehensive survey is recommended.

The total quantity of locally grown softwood sold during 1936-37 was valued at £24,000 whereas imports were valued at £2,240,000 exclusive of box shooks to the value of £622,000. The total imports of timber and timber products in 1937 amounted to over £5,000,000.

In spite of this enormous local market the Board finds the local sawmilling industry, with few exceptions, under-developed, badly equipped, inefficiently organized, insufficiently and irregularly supplied with logs, and under-capitalized, in fact having very few redeeming features at all to its credit.

In contrast with the above the Board comments favourably on the good results accomplished at the Forest Products Institute, and more particularly on the Government plant at Elandshoek where principally box shooks are turned out on a commercial scale.

Although not specifically stated it would appear that the policy of selling logs on the stump or delivered on rail still holds and that it is only when these methods fail that Government conversion should be resorted to. In this connection the Board recommends that work be undertaken in two distinct stages: firstly production of seasoned rough sawn boards by the Government, and secondly, their remanufacture by private enterprise at central plants. This should in

the opinion of the Board be enunciated as being the policy of the Government with the ultimate result that Departmental mills other than break down mills, be disposed of to the public.

The marketing of products from Government break down mills is dealt with in Chapter VII, section 39c, in which it is recommended that "rough sawn boards, properly air-seasoned, be sold at a uniform f.o.r. price to all approved sawmills throughout the country." In the case of manufactured box shooks, the Board considers "that co-operative associations of producers should constitute an important link between the sawmills and the ultimate users of box shooks in so far as primary producers are concerned."

Building timbers produced by the Government should be sold to other Government Departments through the Union Tender Board, or to the Public through the existing marketing organizations either by auction or by formal tender.

Whichever way the timber is sold upset prices will be based on those charged for similar grades of imported timber.

While there are points in the Board's Report which would require reconsideration, the bulk of its content should prove of material assistance in building up a sound South African timber industry.

N.B.E.

FORESTRY ABSTRACTS. Vol. 1. No. 1. 1939. Imperial Forestry Bureau, Oxford.

The inception of *Forestry Abstracts* is a welcome addition to the documentation of current forest literature. The abstract section of the first number, published last June, covers mainly the output of 1938, though a few articles of earlier date are dealt with. The abstracts are preceded by an "annual report" section, giving a series of classified notes on the more generally interesting points contained in dominion and colonial reports for 1937 and 1937-38. The abstracts themselves, printed in double column, are classified on the Dewey system. They vary in length from two or three lines to 500 words, averaging about 150 words. Selection of matter for abstract, judging by the handling of more than one periodical, seems a little capricious; but allowance must be made for difficulties that the compiler alone has to face, particularly in a first issue. The individual abstracts are models of lucid condensation, and the present issue is a mine of valuable information. It is noticed that of the 152 articles dealt with only 26 were accompanied by authors' summaries. It would no doubt be of great assistance to the compilers of this work were authors more generally to adopt the practice of providing summaries with the longer articles contributed to forestry periodicals.

The price of *Forestry Abstracts,* which is to be issued quarterly, to residents of British Commonwealth countries, is 20s. per year. The periodical is attractively produced in a cover of light mauve, which seems to be the adopted colour of the Imperial Agricultural Bureaux, of which the Imperial Forestry Bureau is a constituent body.

PUBLICATIONS RECEIVED
UITGAWES ONTVANG

Copies of the following publications have been received with thanks :

Ontvangs van die volgende uitgawes word met dank erken :

AUSTRALIAN FORESTRY. Vol. iv. No. 1. June 1939.

FOREST AMELIORATION IN THE IRRIGATED REGION OF ZAVOLOSIE, by N. Gorshenin, I. Panfiloff, N. Goudounov, A. Barabanshikoff, and P. Kolomeyzev. Moscow 1934.

FOREST TREES AND TIMBERS OF THE BRITISH EMPIRE. III. Fifteen Uganda Timbers, by W. J. Eggeling, B.Sc., and C. M. Harris, B.A. Oxford, Clarendon Press. 1939.

FORESTRY. Oxford.
Index to vol. i-x. 1939.
Vol. xii No. 1. 1939.

INTERNATIONAL REVIEW OF TIMBER UTILIZATION. No. 4. May 1939.

MICHIGAN ACADEMY OF SCIENCE, ARTS, AND LETTERS.
The Influence of Soil Treatment on Jack-Pine Reproduction, by R. K. LeBarron and F. H. Eyre. Michagan 1939.
An Introduction to the Study of Timber Quality in Lake States Hardwoods, by H. G. White. 1938.

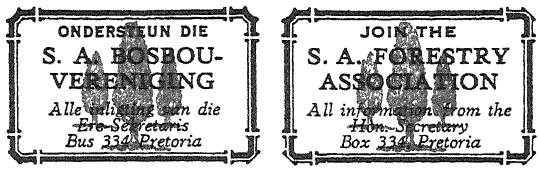
MICHIGAN UNIVERSITY SCHOOL OF FORESTRY AND CONSERVATION.
Circular No. 4. Directory of Primary and Secondary Wood-Using Industries, by W. F. Ramsdell. 1937.
Bull. No. 6. The Spruce Budworm on Michagan Pine, by S. A. Graham. 1935.
Bull. No. 7. Mechanical Properties of Certain Tropical Woods, by W. Kynoch and N. A. Norton. 1938.

PARSKATS PAR KAITĒKLU UN SLIMIBU IZPLATIBU LATVIJAS. Valsts Mezos 1937/38. Riga 1939.

PHILIPPINE JOURNAL OF FORESTRY. Manila. 1939.
Vol 2. No. 1.
No. 2.

TIJDSCHRIFT DER NEDERLANDSCHE HEIDEMAATSCHAPPIJ. Aflewerings 2 tot 9. 1939.

THE ASSOCIATION'S PUBLICITY STAMPS
REKLAMESEËLS VAN DIE VERENIGING



The executive committee has arranged to have adhesive stamps, designed as above, printed in panes of ten, for distribution to members at a nominal charge. The object of this departure is to enable individual members to assist in making the Association known by affixing the stamps to envelopes of letters addressed to such of their acquaintances as may be regarded as prospective new members. The stamps may be obtained from the Hon. Secretary, P.O. Box 334, Pretoria, at the price of twopence per pane.

Dit word deur die uitvoerende komitee gereël om reklameseëls, soos hierbo geillustreer, vir uitdeling onder lede teen 'n nominale prys, te laat druk. Dit word aan die hand gegee dat hierdie seëls op briefkoeverte, gerig aan vriende, wat as moontlike nuwe lede beskou kan word, geplak sal word, om sodoende die Vereniging te help bekend maak. Seëls in geperforeerde blaaie, van tien elk, kan teen twee pennies per blad by die ere-sekretaris, P.K. Bus 334, Pretoria, verkry word.

Die

Tydskrif van die Suid-Afrikaanse Bosbouvereniging

April

UITGEGEE DEUR DIE VERENIGING
April en Oktober

The

Journal of the South African Forestry Association

April

PUBLISHED BY THE ASSOCIATION
April and October

No. 4. 1940
PRETORIA
6/-

SUID-AFRIKAANSE BOSBOUVERENIGING

Beskermheer:

SY EKSELLENSIE DIE GOEWERNEUR-GENERAAL,
DIE HOOGEDELAGBARE SIR PATRICK DUNCAN,
G.C.M.G., K.C.

President:

DIE EDELAGBARE KOLONEL DENEYS REITZ, L.V.

Vise-Presidente:

DIE EDELAGBARE KOLONEL W. R. COLLINS, L.V., D.T.D., D.S.O.
HANS MERENSKY, DR.ING.H.C., D.SC.
H. J. VAN DER BIJL, D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.
P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.
C. E. LEGAT, C.B.E., B.SC.

AMPSDRAERS:

Voorsitter: J. D. KEET, DIP.FOR., M.SC. (ERE.)
Vise-Voorsitter: H. A. READ, F.S.A.A.
Ere-Redakteur: J. M. TURNBULL, DIP.FOR.
Ere-Sekretaris-Tesourier: E. K. MARSH, B.A.

Uitvoerende Komitee:

J. D. KEET, DIP.FOR., M.SC. (ERE.), (*Voorsitter*)
H. A. READ, F.S.A.A. (*Vise-Voorsitter*)
D. R. DE WET, B.SC., L.I.K.B. (WAG.)
CONNELL O'C. MAGGS, B.A., B.SC.
PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.
J. M. TURNBULL, DIP.FOR. (*Ere-Redakteur*)
E. K. MARSH, B.A. (*Ere-Sek.-Tes.*)

SOUTH AFRICAN FORESTRY ASSOCIATION

Patron:

HIS EXCELLENCY THE GOVERNOR-GENERAL,
THE RIGHT HON. SIR PATRICK DUNCAN, G.C.M.G., K.C.

President:

COLONEL THE HONOURABLE DENEYS REITZ, M.P.

Vice-Presidents:

COLONEL THE HONOURABLE W. R. COLLINS, M.P., D.T.D., D.S.O.
HANS MERENSKY, DR.ING.H.C., D.SC.
H. J. VAN DER BIJL, PH.D., D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.
P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.
C. E. LEGAT, C.B.E., B.SC.

OFFICERS:

Chairman: J. D. KEET, DIP.FOR., M.SC. (HON.)
Vice-Chairman: H. A. READ, F.S.A.A.
Hon. Editor: J. M. TURNBULL, DIP.FOR.
Hon. Secretary-Treasurer: E. K. MARSH, B.A.

Executive Committee:

J. D. KEET, DIP.FOR., M.SC. (HON.), (*Chairman*)
H. A. READ, F.S.A.A. (*Vice-Chairman*)
D. R. DE WET, B.SC., L.I.K.B. (WAG.)
CONNEL O'C. MAGGS, B.A., B.SC.
PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.
J. M. TURNBULL, DIP.FOR. (*Editor*)
E. K. MARSH, B.A., (*Sec.-Treas.*)

REDAKSIE-KOMITEE.

J. M. TURNBULL, DIP.FOR.—*Voorsitter.*

I. J. CRAIB, M.F., PH.D.

A. JURRIAANSE, B.Sc. (LB.), B.Sc. (BSB.)

J. D. KEET, M.A. (ERE.) (*Ex officio.*)

CONNELL O'C. MAGGS, B.A., B.Sc.

PROFESSOR E. J. NEETHLING, B.A., M.F.

A. J. O'CONNOR, DIP.FOR.

PROFESSOR JOHN PHILLIPS, D.Sc., F.R.S.E., F.L.S.

E. K. MARSH, B.A.—(*Sekretaris*)

Artikels oor alle aspekte van bosbou sal deur die Redaksie-Komitee in oorweging geneem word, en moet aan die Redakteur, ,,Die Tydskrif van die Suid-Afrikaanse Bosbouvereniging,'' Posbus 727, Pretoria, gerig word. Artikels van meer as 1,000 woorde moet van 'n opsomming van nie meer as vyf persent van die lengte van die artikel self, waarvan kopiereg nie voorbehou is nie, vergesel word. Twaalf herdrukke van elke artikel sal kosteloos aan die skrywer daarvan verskaf word. Mits hulle bestel word voor die einde van die maand voorafgaande die van uitgawe, kan herdrukke bo hierdie hoeveelheid teen die volgende pryse vir eenhede van vier teksblaaie verkry word:—

100 *kopies*	£0	16 6
250 ,,	£1	5 6
500 ,,	£2	0 6
1,000 ,,	£3	10 6

Onvolledige eenhede sal teen dieselfde prys as volledige eenhede gereken word. Gedrukte omslae, bestel gelyktydig met die herdrukke, sal voorsien word teen 21/6 per 100, en 2/- per elke 50 bo die eerste 100. Illustrasies ekstra.

Kontribusies sal gepubliseer word in die taal waarin hulle ingestuur word. Opsommings mag in enige of beide amptelike tale ingedien word.

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of opinies van skrywers nie.

Lesers word versoek om die Vereniging se adverteerders waar gerieflik, in aanmerking te neem.

EDITORIAL COMMITTEE.

J. M. TURNBULL, DIP.FOR.—*Chairman.*

I. J. CRAIB, M.F., PH.D.

A. JURRIAANSE, B.SC. (AGRIC.), B.SC. (FY.)

J. D. KEET, M.A. (HON.) (*Ex officio.*)

CONNELL O'C. MAGGS, B.A., B.SC.

PROFESSOR E. J. NEETHLING, B.A., M.F.

A. J. O'CONNOR, DIP.FOR.

PROFESSOR JOHN PHILLIPS, D.SC., F.R.S.E., F.L.S.

E. K. MARSH, B.A.—(*Secretary*)

Contributions on any aspect of forestry or allied subjects will be considered by the Editorial Committee, and should be addressed to the Editor, The Journal of the South African Forestry Association, P.O. Box 727, Pretoria. Articles in excess of 1,000 words should be accompanied by uncopyrighted summaries, not exceeding five per cent. of length of originals. Twelve reprints of each article will be furnished to its author, free. Reprints beyond that number may be obtained, if ordered before the end of the month preceding that of issue, at the following rates per unit of four text pages:—

100	*copies*	£0 16 6
250	,,	£1 5 6
500	,,	£2 0 6
1,000	,,	£3 10 6

Incomplete units will be charged as for complete units. Printed covers ordered at same time as the text will be provided at 21/6 per 100, and 2/- for every 50 in excess thereof. Illustrations extra by arrangement.

Articles will be published in the language in which they are submitted. Summaries may be submitted in either or both official languages.

The Association does not hold itself responsible for statements or views expressed by authors.

Readers are urged to consider the Association's advertisers as occasion may arise.

INHOUD—CONTENTS

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of menings wat deur skywers uitgespreek mag word nie. Met uitsondering van skrywers se opsommings, word kopiereg van alle artikels voorbehou.

The Association does not hold itself responsible for statements or views expressed by authors. With the exception of authors' summaries copyright of all articles is reserved.

PAGE

VAN DIE REDAKSIE—EDITORIAL NOTES AND COMMENTS 1

SCOPE OF THE JOURNAL.

A NEW DEPARTURE.

AN APPEAL FROM CHINA.

NONQUASSI.

FORESTRY AT THE WITWATERSRAND SHOW.

PROFESSOR-EMERITUS S. SCHONLAND.

THE ACCLIMATIZATION OF FRESHWATER GAME FISH IN THE CAPE PROVINCE AND ITS RELATION TO FOREST AREAS, *by A. Cecil Harrison* 5

RAINFALL AND STREAMFLOW AT THE CAPE, *by J. D. M. Keet, Dip.For., M.Sc.* 15

THE BANTU AS FOREST BOTANIST, *by O. B. Miller* 21

THE MANUBI FOREST, *by N. L. King, Dip.For.* 24

DEVELOPMENTS IN PATHOLOGICAL RESEARCH ON WATTLES, *by M. S. J. Ledeboer, Dr.Math. et Phys.* 30

THE UTILISATION OF SOUTH AFRICAN GROWN *Eucalyptus saligna*, *by M. H. Scott, B.Sc.* 46

MINING TIMBER IN SOUTH AFRICA WITH SPECIAL REFERENCE TO WATTLE SILVICULTURE, *by R. P. Stephens, B.A. (Cape), B.A. (Oxon.)* 55

'N BESOEK AAN DIE VERENIGDE STATE SE BOSPRODUKTE LABORATORIUM TE MADISON, *deur D. P. Ackerman, B.Sc., M.F.* 75

THE CAROB OR LOCUST TREE (*Ceratonia siliqua* L), *by E. E. M. Loock, B.Sc.* 78

KORRESPONDENSIE—CORRESPONDENCE 81

Eucalyptus saligna—PLEA FOR A LONG TERM POLICY.

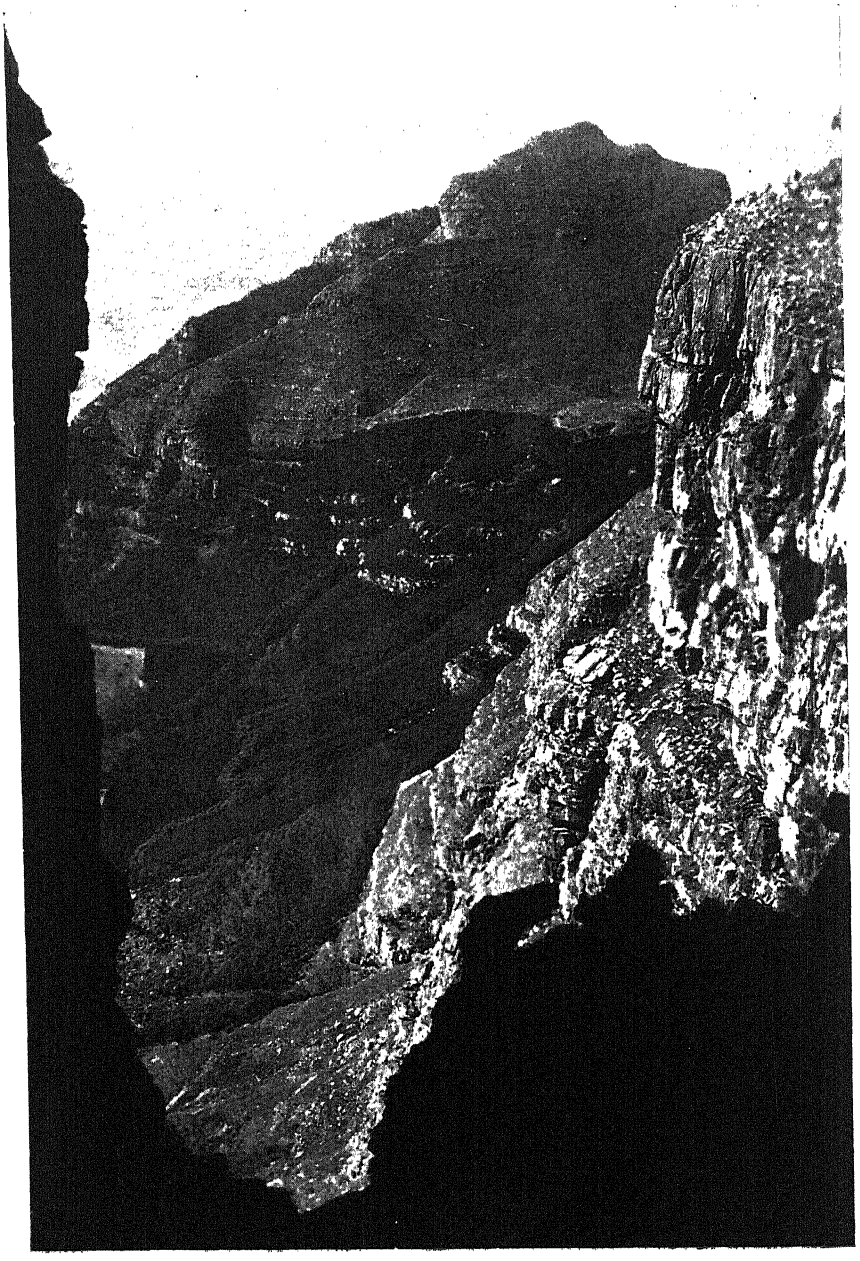
GOEDKOOP DOKTORSGRADE IN DIE BOSBOUWETENSKAP.

RESENSIES—REVIEWS 86

WOOD PRESERVATION.

THE EMPIRE FORESTRY JOURNAL.

ADDENDA



Pine-clad slopes of Devil's Peak, Cape.

DIE TYDSKRIF VAN DIE
SUID-AFRIKAANSE BOSBOUVERENIGING
No. 4. APRIL, 1940.

THE JOURNAL OF THE
SOUTH AFRICAN FORESTRY ASSOCIATION
No. 4. APRIL, 1940.

VAN DIE REDAKSIE.

EDITORIAL NOTES AND COMMENTS.

Scope of the Journal.

While some readers complain that the tone of our Journal is too technical, others are of opinion that the balance between severely technical papers and articles of more general interest is being adequately maintained. It must be admitted that the former predominate, and it accordingly behoves us to give their plea sympathetic consideration. Of our four hundred members, a considerable proportion are not concerned with technical aspects of forestry. They are lovers of trees or ordinary citizens eager to secure to their country as many as possible of the amenities and economic benefits that trees and forestry activities can bestow. While it would be absurd to decline the privilege of publishing any paper that breaks new ground in forestry science merely because few readers are technically equipped to grasp its significance, the legitimate claims of all classes of readers should be acceded to as far as possible, and we accordingly appeal to members, especially those amongst the lay section, who have the necessary bent, to take up their pens and help temper the severity of our more technical pages.

Wide satisfaction amongst existing readers will help greatly in attracting new ones. It will not be easy of achievement. The scope of forestry embraces a multitude of interests. It is not only the chasm between forester and layman that demands bridging, but also that between forester and forester. Discussion of the finer points of sylvicultural technique may be Greek to the wood technician, and even in the wide realm of the latter there are many arcs that never touch. It is not necessarily the most widely read articles that advance the cause of forestry. A technical paper, definitely breaking new ground, may arrest the attention of but one receptive reader. Its theme has

put forth a hypha, however, and attached a fresh cell, and the mycelium will spread. Nature's workings are not so much complicated as hidden. The further they are exposed the more generally intelligible they appear. The strike of a newly exposed lode is not apparent until the lode is bared at some new point. The most esoteric discovery becomes divested of mystery as new workers develop it and associate it with more familiar phenomena, until eventually its significance, in a flash, is revealed to the layman. Discovery is everyman's heritage.

Our Association and our Journal are still in their infancy. They have brought many different interests together. Some of these the Journal has already specifically catered for; some, in future issues, it will. Meanwhile true forest conditions are gradually establishing themselves, and balance between imparted information and receptivity asserting itself. May equilibrium once achieved persist, and the former never thereafter transpire beyond the capacity of the latter!

A New Departure.

In furtherance of the aims expressed above, the scope of the Journal, in this issue, is widened to include an article of angling interest. Fishes and fishing are inseparably associated with forestry, and as fresh water fishing is assuming ever-increasing popularity in South Africa, it is felt that Mr. Harrison's article will be welcomed by many readers. It is hoped in future issues to continue the vein, probably with studies of the most highly prized individual species inhabiting our streams and reservoirs.

An Appeal From China.

China is not losing sight of the task of reconstruction that will one day claim the ingenuity of her rulers. The part that forestry should play in a country's national economy, and the need for scientific management of its woodland wealth, in the midst of a titanic struggle to maintain her national existence, are engaging earnest attention. This is apparent from a circular letter just received from the Head of her National Central University. The letter, which is printed below speaks for itself.

Sha-Pin-Bah, Chungking,
Szechuan, China.
6th Feb., 1940.

Sir,

In spite of war conditions which necessitated our removal to the interior of China, the Department of Forestry of the National Central University is carrying on its work as usual. With the opening of the next term, two whole years have elapsed since we were ordered, in the Autumn of 1937, to shift from Nanking to Chungking. New surroundings and many other difficulties, however, have not influenced our efforts, and reports are being drawn up on how our curriculum is being conducted as well as on the scope of experimental activities and technical co-operation with governmental and commercial enterprises for the development and utilization of forests in Western China.

It is a great regret to us that, due to the war, we have lost contact with forestry institutions in foreign lands. Now that things are settling down, we hasten, through this circular, to inform you of our new address, and hope that you will put us on your mail list for the exchange of publications.

Yours truly,

Y.K.Li.

(Head of the Department of Forestry).

NONQUASSI.

In connection with the foot-note to Mr. King's article on the Manubi Forest on page 28 of the present issue, we have just learnt that a cinemetographic version of the story concerned has been made by Mr. Leon Schauder, of Port Elizabeth. The film is entitled "Nonquassi," after the maiden to whom the vision of the white men's enemies was revealed. The whole episode is an instance of national suicide, and the world rights of the film have been acquired by the British government in order to illustrate how a nation may be destroyed by its enemies from within.

FORESTRY AT THE WITWATERSRAND SHOW.

The character of the Division of Forestry's agricultural show exhibits is changing. That at the Easter Witwatersrand show this year was staged so as to reflect the phase that forestry in South Africa is now entering. For many years the Government has concentrated on the establishment of potential supplies of softwood timber, and its foresters in the year or two before the outbreak of war were confronted with the problem of finding markets for a vast volume of wood accruing from intermediate fellings. The exhibit testifies to no small measure of success in this direction, and brings out forcibly the fact that forestry in South Africa is no longer an activity isolated from other branches of national progress. It is growing up and definitely taking its place in the national economy. On the exhibit could be seen box shooks, beer and mineral water boxes, wood pulp, matches, and wagon and furniture wood : not as mere samples demonstrating potential uses, but supplied from the normal stock in trade of the industries represented. The full scale front of a weatherboard cottage, cleverly constructed so as to project a few feet from the end of the exhibition hall, suggested still further outlets for the prospective yields from our plantations, though in present circumstances, and until large areas of pines mature, wood for uses is likely to present a greater problem than uses for wood.

PROFESSOR EMERITUS S. SCHONLAND.

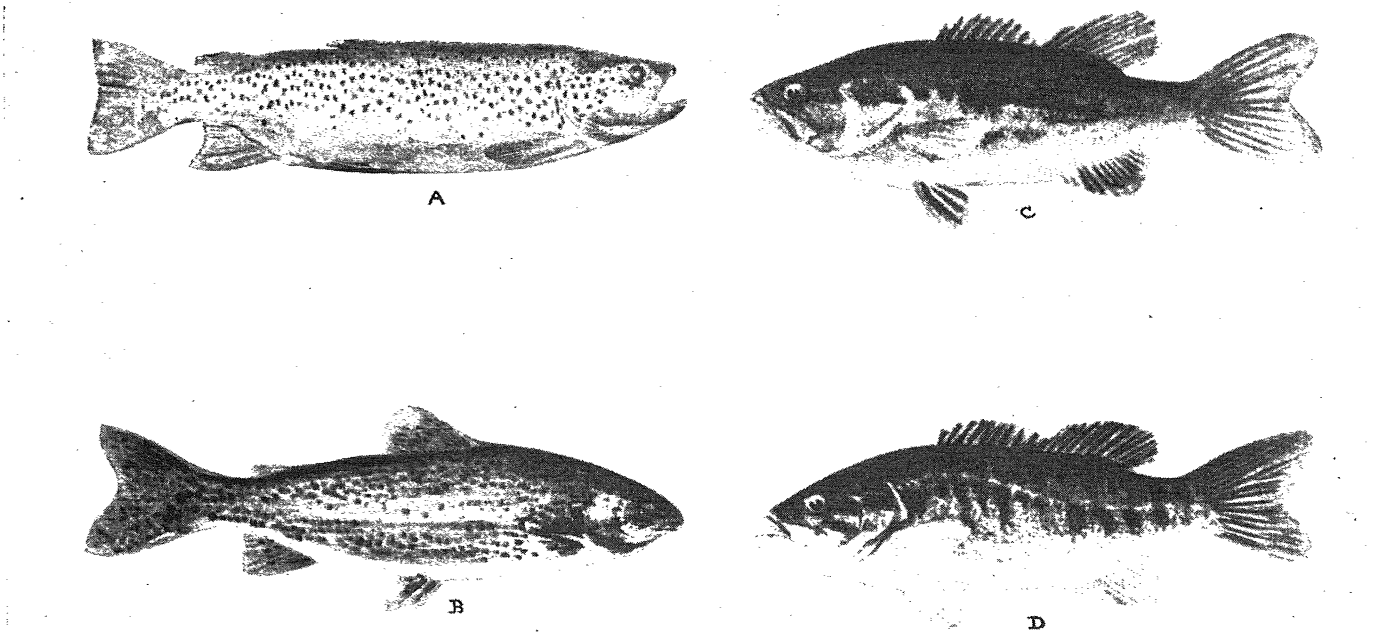
It is with deep regret that we record the passing of the doyen of South African botanists, Professor S. Schonland, one-time Professor of Botany, Rhodes University College, Grahamstown and Regional Botanist, Botanical Survey of the Union of South Africa.

Professor Schonland made notable contributions to our knowledge of the distribution and systematics of the flora of the Eastern Cape Province, and did much to stimulate interest in the values likely to follow Governmental support of applied botanical studies.

At one time intimately associated with the development of the Albany Museum and the Albany Museum Herbarium, Professor Schonland did splendid work for the institution later to be known as Rhodes University College. Not only was he a distinguished and able member of the academic staff, but he did much to guide the growing college in many other directions. Quiet, unassuming, thorough, critical, he proved a staunch pillar to the institution.

So far as forestry is concerned, Professor Schonland assisted by identifying material sent him from time to time, and in collecting, identifying and filing material collected by forest officers and others in the George - Knysna - Humansdorp - Alexandria - Kaffrarian - Transkeian forest areas.

He monographed, inter alia, the genus Rhus and the family Crassulaceae.



FOUR ACCLIMATISED GAME FISH.—A. Brown trout. B. Rainbow trout. C. Largemouth black bass. D. Smallmouth black bass.

THE ACCLIMATIZATION OF FRESHWATER GAME FISH IN THE CAPE PROVINCE AND ITS RELATION TO FOREST AREAS

By A. CECIL HARRISON

(*Inland Fisheries Advisory Officer, Cape Provincial Administration.*)

IN the Cape Province south of latitude 31 deg. 30 min., from the Olifants River on the west to the Umzimvubu River on the east, the streams and rivers flowing coastwise are poorly endowed by nature with freshwater fishes of interest to the angler and of merit for the table. For this reason, our inland fisheries development work has centered on the acclimatization of exotic species.

The only sizeable species of true freshwater fishes in the whole fauna are five members of the great Carp family (Cyprinidae), of which four species are confined to three river systems in the west of this region, viz. the yellowfish (*Barbus capensis*), the sawfin (*Barbus serra*) and the sandfish (*Labeo seeberi*), all endemic to the Olifants River system; and the witvis or baardman (*Barbus andrewi*) which is common to both the Great Berg River and the Breede River systems (Barnard, 1938). The fifth species (*Labeo umbratus*), known by various names such as mogga, moggel, mud fish or mud-mullet, is a very bony and almost worthless inhabitant of the rivers of the Karoo series; but otherwise, it is a remarkable fact that sizeable indigenous freshwater fish are totally absent from all the river systems reaching the coast between longitudes 21 deg. and 29 deg. 30 min. E., i.e. from the Duivenhoks River, Heidelberg, to Port St. Johns This category does not include the common eel (*Anguilla mossambica*) of the fresh waters connecting with the sea to the east of Cape Point, nor the estuarine fishes which ascend well into fresh water, such as the grey mullets (*Mugil spp.*) generally called springers or haarders, and other well known forms of interest only to anglers near the coast. The abundance of small forms such as the *Galaxias* or mountain minnows, the Cape "kurpers" or rockies (*Spirobranchus*), and small species of *Barbus* known as rooivlerks and gillieminkies, is noted here on account of their potential food value for imported game fish. Many river systems would to-day be entirely free from large coarse fish had not man supplied the "carp curse" by the indiscriminate introduction of the exotic mirror carp (*Cyprinus carpio*), with deplorable results in some trout streams and elsewhere to the detriment of more desirable warm water species.

Hundreds of upland streams in this region were, or still are, quite devoid of freshwater game fish and the first step towards inland fisheries development was naturally the acclimatization of trout. Interest in inland fisheries is of comparatively recent origin, as the country had to be advanced for over two centuries before such a side issue could be raised. The matter was taken up in the first place by a few private enthusiasts, and largely at their own expense, before it was given attention as a matter of any public importance by the Cape Government in 1890. Although Act No. 10 of 1867 provided "for encouraging the

introduction into the waters of this Colony of fishes not native to such waters," nothing seems to have been done at that time beyond the private importation of carp and goldfish which were able to survive even the protracted sea voyages of those days.

Inspired by the success of the acclimatization work with salmonoid fishes in Australasia, for to Tasmania the first shipments of ova had been made unsuccessfully as early as 1849, and after repeated efforts with success in 1864 (Tenison-Woods, 1883), a small private syndicate brought out a consignment of several thousands of salmon and trout ova in 1875 in the icehouse of the old *Windsor Castle.* Some were landed at Cape Town and some were sent on to Durban, but all failed to hatch. The prime mover in Cape Town at that time was Mr. Charles A. Fairbridge. In 1882, Mr. J. D. Ellis, of Kingwilliamstown, got out a consignment of trout ova with only a transitory measure of success. During the period 1881 to 1883, Mr. J. C. Parker was attempting to introduce salmon and trout into Natal.

It was mainly due to the drive and enthusiasm of Mr. Lachlan Maclean, Agent of Donald Currie's Castle Mail Packet Company in Cape Town, that trout acclimatization was at length achieved in the Western Province, and that the Cape Government was induced to sponsor and later to take over the undertaking. After visiting the International Fisheries Exhibition held in London in 1883, Mr. Maclean embarked on another private venture, and in 1884 he brought out 20,000 brown trout ova. The shipping technique must have been greatly improved over that of the previous attempts, as it is recorded (Gilchrist, 1898; Manning, 1908; Thompson, 1913) that the eggs were taken from Cape Town to a woolwashery near Ceres Road station (close to Kluitjeskraal, Wolseley, and that about 17,000 fry hatched out. But the rapid oxidising effect of our soft water on the zinc sheeting used in connection with the hatching troughs had not been realised and calamitous mortality resulted. There were only 60 survivors, and even then all but three were washed away during heavy floods. History does not claim any success for this premature incursion into the Breede River, but records that the three remaining trout were kept in a pond until 1890, when they died on account of high water temperature during a severe drought, and that one of about 3 lb. was preserved in Mr. Maclean's office in Cape Town.

Mr. Maclean persisted in urging the Cape Government to take the matter in hand, and in 1890 provision was made on the Estimates and the Colonial Secretary, the Hon. Mr. J. W. Sauer, requested Mr. Maclean and his associates to undertake the supervision of the work. Mr. Anders Ohlsson, M.L.A., granted the use of the old Mill House at the Anneberg Brewery, Newlands, near Cape Town, for a hatchery. The water was supplied from the famous Newlands Spring, noted for its purity and even temperature. Early in 1892, Mr. Ernest La Tour, an expert selected for the work by the Agent-General in London, brought out 100,000 brown trout ova supplied by Mr. Thomas Andrews of Guildford, England. Contemporary accounts are somewhat at variance, but it seems evident that again the deleterious effects of soft water upon parts of the hatching equipment had not been anticipated and that results were rather poor. A second consignment sent out unattended arrived in almost worthless state, but a third lot opened-up in good condition and hatched well. The funds voted did not allow for the

construction of adequate rearing ponds for the fry, and it is recorded that when in 1893 another large consignment of ova arrived, emergency measures were taken and a large number of brown trout ova were planted out in gravel redds in the head waters of the Eerste River above Stellenbosch; and shortly afterwards about 20,000 young fry, hatched from the remainder of the shipment at Newlands, were liberated in the Breede, Berg, Eerste and Lourens Rivers. However, in 1893, the Government secured the lease from Mr. F. G. Watermeyer of a hatchery site on his farm "Jonkershoek" in the Eerste River valley about 6 miles above Stellenbosch, where a small mountain stream (now known as the Bosboukloof Stream) was diverted to feed a permanent hatching house and series of trout ponds. The Government had secured the services of Mr. John L. Scott, from the Solway Fisheries, Dumfries, Scotland, for the new work, and a stock of some 400 brown trout, reared from the earlier shipments of eggs, was transferred from Newlands to the new ponds at Jonkershoek during 1894. Quite recently, the writer was informed by the gentleman who did the actual transport work on behalf of Mr. Maclean that this job took many weeks to finish, as some of the trout were large adults and only a few could be taken at a time by train and Cape cart. This is borne out by Scott's first report (Scott, 1895) in which he states that many of the 3-year-olds weighed about 5 lb. each after some months at the Hatchery; and he also records that the balance of the Newlands stock—4,000 to 5,000 fingerlings about 6 months old—were distributed in various rivers. The pioneer work in the Cape Peninsula had therefore ensured the establishment of brown trout in the Western Province.

The first crop of brown trout ova, artificially "stripped" and impregnated from the imported breeding stock at Jonkershoek, was taken in June, 1895. Scott found that the trout yielded less ova per fish than had been usual in his experience in Scotland, and that the ripening of the females to the point of spawning was very irregular, a disability with brown trout in this climate which has troubled Cape fish-culturists from that day to this. At first only young fry were distributed, to local streams; but in 1896, the system of sending "eyed ova" (i.e. eggs with advanced embryoes, which can withstand lengthy transport packed in damp moss) by parcels post was instituted, and some thousands were sent over long distances and were received in good condition. By this system many streams in southern Africa have been stocked with trout from the Cape hatcheries.

In 1896, two boxes of rainbow trout ova were imported for Jonkershoek but all were bad on arrival. The shipment was repeated in 1897 and some fry were obtained, which grew exceptionally well. In July, 1899 (for from the very first the rainbows spawned a month later than the brown trout), Scott stripped his first "Colonial" rainbow trout ova, and noted that the eggs hatched quicker than those of the brown trout. He took 14,000 ova from his two-year-old breeders and distributions were commenced.

The earliest attempt at acclimatizing trout in the Eastern Province was that made by Mr. J. D. Ellis, of Kingwilliamstown, in 1882. It seems that when the consignment was opened-up there were distinct prospects of success, but the eggs had arrived during the heat of the South African summer and the journey from East London to a temporary hatchery in a small stream about 18 miles from Kingwilliamstown was

almost too much for them and only about 10 per cent. arrived in a vital state. Hatching was fairly promising, but within six weeks all the fry had perished and this first attempt had concluded in failure. The experiment had shown the way, and in 1894 the trout pioneers of the Eastern Province founded the Frontier Acclimatization Society, and aided by a Cape Government grant, which has been continued by the Cape Provincial Administration, a regular hatchery was established in the Perie Forest Reserve about 14 miles north of Kingwilliamstown. For several years trout ova were imported in considerable quantities with small success, one adverse factor being the distance of this hatchery from the seaport in those days of slow land transport. Here it should be appreciated that trout ova are available only in winter in both hemispheres, and that the period of incubation can be greatly retarded by low temperature either in nature or under artificial cold-storage. But even the tardiest trout ova from the European winter, sent out in the ship's cold chamber, have to be opened-up here when it is still late summer, and when the water temperature in most streams is too high for the healthy incubation of the ova and for the tender young fry. Survivors from the various shipments of brown trout ova formed a nucleus breeding stock at the Perie Hatchery however, and in 1897 the first stripping of ova took place. Rainbow trout were afterwards acquired.

The Perie Hatchery contributed largely to the stocking of streams in the Eastern Province and was soon sending out packages of eyed ova far afield in South Africa. This work has been continued without intermission to the present day.

Two attempts were made to introduce Atlantic salmon (*Salmo salar*) to the Jonkershoek Hatchery. The first in 1896 was promising in its early stages, as it is recorded that about 5,000 fry were hatched and placed in a rearing pond but that they were washed down into the Eerste River when the screens gave way during a heavy rain storm. The second lot of salmon ova arrived in April, 1897, and again there was a fair yield of fry, which were reared in ponds like trout with considerable success. Scott reported that about 5,000 young salmon "six to nine inches long and beginning to put on the smolt scales previous to going to the sea about November" were carted over the Helshogte Pass and released in the Dwaars River at Banhoek, a tributary of the Great Berg River. "They may possibly return about June or July 1899," wrote Scott, but nothing was ever seen again of the Eerste River or Berg River salmon. If any survived to migrate to the sea, they never came back. The Frontier Acclimatization Society also made an attempt to establish salmon in the Eastern Province and in 1898 about 8,000 fry from imported ova were released in the Rabula stream, a tributary of the Keiskama River, but again, that was the last seen of them. Experiments with British sea trout ova at the Cape hatcheries were unsuccessful, none of the fry surviving the early stages; and an attempt with American eastern brook trout ova, imported from England to the Jonkershoek Hatchery, suffered the same fate.

From the earliest days of trout acclimatization, Forest Officers have shown keen interest in the work of stocking the streams of their districts, and in some cases they have been solely responsible for the establishment of trout in out-of-the-way places. But inland fisheries work in this Province, like all other branches of human endeavour

involving the acclimatization of exotic species, has been fraught with failures, and many Forest Officers have borne the brunt of pioneering efforts with trout which were unsuccessful. Their work has not been forgotten and some enlightening data have been recorded concerning such failures. The trout acclimatization work started in the early 'nineties, when a great deal had been learnt about the productivity of land but very little about water. Although to-day we can draw on a greater scientific background and can venture on prediction concerning the prospects of trout in a particular type of aquatic environment, there is always the comforting assurance in mind that nearly every stream of this region has been given its chance to acquire trout at some time during the last 45 years, and often more than one chance. Streams eminently suitable for trout acquired them, sometimes easily enough, sometimes only after repeated attempts to overcome technical difficulties not connected with the suitability of the water; but a number of streams on which equal care was lavished just did not (Chaplin, 1903 et seq. : S.A. Hey, 1925-27). For over thirty years, the trout was the only game fish available for distribution from the Cape hatcheries, and it was the ambition of all enthusiasts who had any sort of water available to establish trout. Although there were many outstanding successes there were probably far more failures due to the unsuitability of the environments offered, and many thousands of trout ova have been expended in abortive attempts. Trout are confined to rather specialised areas in all countries, and it is now almost safe to say that the limits of the trout areas in the Cape Province have been fixed by a lengthy process of trial and error.

Of late years there has been marked deterioration of trout producing waters in some areas where streams are losing their original volume and purity. Many streams now almost cease to flow in the lower reaches on account of the abstraction of water for irrigation at certain times of the year, and industrial pollution has reared its ugly head. It is indeed fortunate for the future of our trout fisheries that great areas of mountains and upland valleys are under permanent conservation by the Division of Forestry, well above the irrigation line. As things are shaping to-day in the more populated areas, it seems that in the future suitable water conditions for trout will remain only in the uplands. As it has not been essential for anglers to climb to the upper levels of the streams for their sport, little attention has been given to the desirability of stream bed improvement, which has figured largely in inland fisheries work in other countries. Large trout are rarely found in upland streams except in good holding pools, and the upper reaches of many of our successful trout streams are very deficient in this respect. It is always remarkable that where there is a fortunate assembly of boulders in the stream bed, or even a line of stepping stones at low water over which floods pass without check, there will be a holding pool for sizeable trout. In many instances, the natural pools of the stream bed are almost unapproachable on account of thick native bush and marshy vegetation unless ways are cleared. Improvements to stream beds and of access to fishing pools are matters for riparian owners, and where the Division has full riparian rights and levies charges for angling permits under the regulations, perhaps the suggestion may be permitted that improvements on behalf of anglers should be given more attention.

The year 1930 ushered in a new era of inland fisheries development in South Africa, for in that year largemouth black bass became available for distribution from the Jonkershoek Hatchery and a little later from the Perie Hatchery (Harrison, 1934 and 1936). During the last ten years there has been a great increase in the yield of the inland fisheries of the Cape Province due to the establishment of largemouth bass in sluggish waters which are unsuitable for trout, and as they are excellent table fish they have become quite an asset in many inland districts. In fact there are probably as many people now interested in largemouth bass as in trout, on account of the widespread distribution of the former. The largemouth bass is not a stream fish, and if placed in a river it will populate the sluggish reaches and larger pools in association with the coarse fish on which it preys. It breeds very freely in shallow quiet backwaters, when the water warms up in spring and early summer. It has become very abundant in parts of the Olifants, Berg, Breede and Sonderend Rivers in the dry summer area of the Western Province, but on account of its breeding requirements there are still some doubts about its ability to multiply in the rivers subject to summer floods. It thrives in waters which are too warm and turbid for trout, and it is now definitely proved that the peat-stained acid waters of the southern coastal belt do not affect its growth and productivity so unfavourably as they have in the case of trout. The largemouth bass is however a fish of the lowlands and standing waters, and is perhaps more to be associated with irrigation projects than forest reserves. There are several instances where it has been introduced with success into dams controlled by the Division, and, notably in the case of George and Knysna, where bass produced in such dams have been distributed to the sluggish portions of rivers for the general benefit of the fisheries of the district.

Before returning to the subject of the upland streams, it should be mentioned that on account of their voracious appetite for fish, frogs, crabs and other aquatic organisms, a dam for staple bass production should have a fairly large acreage. The live food supply in small dams soon becomes exhausted by the bass. In order to provide a smaller and less exacting fish for small waters, but moreover a fish with a high reputation as a table fish and minor sporting fish, the Jonkershoek Hatchery has acquired a stock of American bluegill sunfish (*Lepomis macrochirus*) which were imported from New York in October, 1938. The bluegill belongs to the same family as the black bass (Centrarchidae) but does not attain a size of much above a pound in its native habitat. It is a very precocious breeder and exceedingly prolific, and is propagated and distributed in millions annually from many hatcheries in the United States for re-stocking the heavily fished waters. The imported stock at the Jonkershoek Hatchery commenced to breed when they were only seven months old in January, 1939, and it was possible to begin the distribution of this new fish only a few months after the original stock had been received.

The year 1940 may well be the commencement of a third era of inland fisheries progress in the Cape Province, during which whole streams and portions of streams that for ecological reasons have not benefitted from the introduction of trout may be stocked with more adaptable species of game fish. At the Empire Forestry Conference of 1935, Mr. J. D. Keet used a very apt phrase in connection with the necessity of working in conformity with ecological principles, it was

"the knack of matching species to growing sites." If this is true in forestry it is no less true in fish acclimatization. For many years attempts have been made to fit trout into unsuitable "growing sites." In the case of the peat-stained waters, whilst the growth of some trout introduced from the hatchery has been fairly good, natural reproduction has been very poor. Many streams, or portions of streams, attain water temperatures which are far too high for good populations of trout. In the western part of this region, coupled with the high stream temperature factor there is often space competition with native coarse fish, which trout cannot tolerate. In some instances there are straggling trout populations occupying long stretches of river—a trout fishery in theory but of very little angling value in practice. It is not for one moment to be suggested that trout established in optimum environments should be made to give way for any other acclimatized fish. But in many cases it has been shown empirically that it is a waste of time, money and fishing water to persist with trout, and stream survey work can often suggest the reasons for failure.

The introduction of the northen smallmouth black bass (*Micropterus dolomieu*) to South Africa was advocated after the success of its large-mouthed cousin was assured. The smallmouth bass is considered to be superior to the largemouth in several respects and has a different range of voluntary toleration. It is more suitable for introduction into clear upland reservoirs and into the stony parts of rivers which are rather too warm for trout. Thus in the theoretical case of a clear river undergoing normal topographical changes in its passage from the mountains, through uplands and lowlands, the smalmouth bass would fill the position left vacant in the present distribution of imported game fish and would improve the fishing waters which lie between the upper trout waters and the sluggish lower reaches held by the largemouth species.

A small stock of northern smallmouth black bass was imported from New York in October, 1937, and the Cape Provincial Administration took charge of them for propagation at the Jonkershoek Hatchery. They showed great adaptability to our climate, and American fisheries experts pronounced it as a record when they bred in September-October, 1938, at the age of only 17 months. A good crop of fingerlings was obtained and a number distributed, and this dispersal has been continued after the second breeding season in 1939.

The ability of smallmouth bass to thrive in one type of river environment has soon been proved. By the courtesy of the Secretary for Agriculture and Forestry, the inland fisheries officials of the Cape Provincial Administration were permitted to use a section of the upper Berg River, passing through the Western Province Fruit Research Station at Groot Drakenstein, for fish experiments. This section is mainly stony and is within the trout area, but it produces very few trout in the course of a year and is scarcely worth a trout angler's day. The water is that of a fair trout stream, clear and practically neutral in pH when low, and with a light vegetable stain and slight acidity after rains. The limiting factors for trout are most probably the high temperature of the water in summer—stream temperature, in shade, below long rapids, 4 p.m. January 20th, 1935, 83 deg. Fahr. (Harrison, 1936)—and the large population of indigenous coarse fish, (witvis, *Barbus andrewi*). Largemouth bass were introduced into this part

of the Berg River in 1930, and although their nests have been found when water conditions are favourable in spring and shoals of well grown fingerlings are evident in summer, the majority seem invariably to drop downstream with the first floods to the sluggish lower reaches, and only a few adults remain on the section. The introduction of largemouth bass has in fact done very little to improve the angling prospects in this stony part of the Berg River, and ever since the importation of smallmouth bass was first mooted it had been held in mind as a "vacant area" awaiting their occupation. During December, 1938, and January, 1939, about 300 smallmouth bass fingerlings from the first breeding of the imported parents at Jonkershoek were planted in this test section of the Berg River. For the first few weeks, during a period of very low and clear water, their progress could be watched and it was seen that they were making good growth upon the abundant supply of fry of the native fish. Thereafter, they dispersed and the issue was in doubt during the high water periods of 1939. When the river was again low and clear in January, 1940, a number of smallmouth bass were found to have taken up their residence in a stony run suitable for close observations, and it was seen that they had grown to the legal size of 10 inches long during the passage of only 12 months. On March 3rd, 1940, one of these smallmouth bass was caught and preserved as a specimen. It was 12 inches long and weighed 1 lb. 0½oz. at the age of 17 months. Taken on trout tackle, it fought quite as gamely as a rainbow trout. There is every prospect that a number of the smallmouth bass released at Groot Drakenstein will be large enough to breed in the river in the spring months of 1940. Smaller plantings of smallmouth bass fingerlings were made in the lower Holsloot River (Louwshoek) and the lower Wit River (Bainsberg Reserve), which have hard beds and clear water, with warm water and coarse fish to limit trout production, but it is too early to judge results.

A typical aquatic environment of the forest areas in the south western Cape Province along latitude 34 deg. is the peat-stained acid stream from the sandstone. There are numerous fine perennial streams of this nature, apparently ideal for trout, but in which trout have almost invariably failed, in spite of persistent attempts to stock them continued over many years. The reason lies in the extreme acidity of the brown stained water, which has a very deleterious effect upon the fertility of trout (D. Hey, 1940). In some cases, this factor is coupled with high temperature alone, or with high temperature and competing coarse fish. Experiments with largemouth bass in dams of peat-stained acid water at the Cape have proved that the fertility of these fish is far less affected by this type of water (Harrison, 1938), and largemouth bass are now very abundant in the lower reaches of the Sonderend River, which has a very marked peat stain, and are present in the Palmiet River (Elgin) and the Kaffirkuils system (Riversdale). With the co-operation of the City Engineer of Cape Town, experiments with smallmouth bass in peat-stained reservoirs are now in progress. Further tests with the northern smallmouth bass are shortly to be instituted in a few of the peat-stained streams on reserves near to the Jonkershoek Hatchery.

But the possibility that the northern or true smallmouth bass may not answer in warm streams with high peat-stain or turbidity or subject to summer floods has not been overlooked, and the Cape Provincial Administration has now obtained a small stock of the third species of

black bass for propagation at Jonkershoek. This is the spotted or southern smallmouth bass (*Micropterus punctulatus*); an inhabitant of streams in the southerly parts of the United States of America, where it occupies a similar position (as opposed to the largemouth bass of the sluggish waters) to its northern relative, the true smallmouth bass. The stock was obtained in October, 1939, from the State of Ohio, where the spotted bass is limited to the streams of the sandstone-shales region and thrives in water slightly acid or nearly neutral. One of the results of scientific stream survey in that State has been to show that, although for forty years repeated attempts had been made to plant northern smallmouth bass and largemouth bass in the streams of southern Ohio, the spotted bass (which is indigenous and had not been assisted by artificial means) remained the dominant black bass of the lowland streams of that region. The fact that the spotted bass had been able to withstand the repeated invasions of its two closest relatives was taken to indicate the futility of stocking one species of bass in the environment of the other two. (Trautman, 1932). The spotted bass at the Jonkershoek Hatchery have grown very well and it is hoped that they will breed in the spring of 1940.

Conditions in the streams and rivers of the forest areas in the Cape Province are very varied, and there must be many waters which will suit one kind of exotic game fish and not the others.

SUMMARY.

Acclimatization of exotic game fishes was necessary in the Cape Province on account of the paucity of indigenous freshwater fishes of angling and food value. There are only four indigenous species (Cyprinids) of fair size confined to river systems in the extreme south west, one inferior species in Karoo rivers flowing coastwise, and none at all in the Drakensberg-Transkei series.

The history of the importation of salmonoid fishes is reviewd. During 45 years, trout have been tried in a great variety of waters, with success in certain limited areas which offered suitable environment.

Some formerly good trout waters have deteriorated with the extension of agricultural and industrial development, and greater attention to the improvement of upland streams for fishing, particularly in forest reserves, is advocated.

A new era of inland fisheries development started in 1930 when largemouth black bass became available for stocking confined waters and sluggish rivers unsuitable for trout.

It is suggested that a third era may be dated from 1940 now that northern smallmouth bass are available for planting in upland streams where trout have not done well.

The southern smallmouth or spotted bass has also been imported for trial in fast lowland streams.

Conditions in streams and rivers in forest areas are very varied, and there is now more exotic material available than formerly to give scope to the art of matching fish species to different environments.

REFERENCES.

BARNARD, KEPPEL H.: "Notes on the Species of Barbus from the Cape Province," *Ann. & Mag. Nat. Hist.*, Ser. II, vol. ii, p. 80, July 1938.

CHAPLIN, F. G.: Curator's reports re Perie Hatchery 1903-1907; Curator's reports re Jonkershoek Hatchery, year 1908 and onwards; appendices to Rep. Gov.

Biologist, Cape of Good Hope; and since Union in printed and ms. reports to Prov. Secty., Prov. of Cape of Good Hope.

GILCHRIST, J. D. F.: "The Early History of Trout Acclimatisation in South Africa," appendix VI, G. 53-'98, Mar. Bio. Rpt. Year 1897, Cape of Good Hope, Dept. of Agri., Cape Town.

HARRISON, A. CECIL: "Rpt. on the Early History of the Acclimatization of American Largemouth Black Bass in the Cape Province." Inv. Rpt. No. 4, Dept. of Comm. & Ind., Fish. & Mar. Bio. Survey Div., Govt. Printer, Pretoria, 1934. (out of print as separate, included in Ann. Rpt. No. 11 for 1933, Fish. & Mar. Bio. Sur.)

..... "Second rpt. on the Progress of Amer. Largemouth Black Bass." Inv. Rpt. No. 7, Dept. of Comm. & Ind., Fish & Mar. Bio. Survey Div., Govt. Printer, Pretoria, 1936. (Price 2s. 6d. in separate Afrikaans and Eng. versions).

..... "Largemouth Bass Breeding in Brown, Acid Water; Malkop Vlei, Caledon Division; & Dam on Farm at Noordhoek, Cape Peninsula." 7th Ann. Rpt. Cape Piscatorial Society, Cape Town. Aug. 1938.

HEY, DOUGLAS: "A Preliminary Rpt. on the Reproduction of Trout in the Steenbras Reservoir." Circ. No. 35, gratis, Cape Piscatorial Society, Cape Town. March 1940.

HEY, S.A.: Inland Waters Survey Reports, No. 1, 1925-26, No. 2, 1925-6, No. 3, 1926-7. Dept. of Mines & Ind., Govt. Prin. & Stat. Off., Pretoria.

MANNING, DUMARESQ W.: "Trout Fishing in the Cape Colony," Argus P. & P. Co. Ltd. Cape Town. 1908.

SCOTT, JOHN, L.: Overseer's Reports re Jonkershoek Hatchery, for years 1894 to 1906, appendices to Rep. Govt. Biologist, Dept. of Agri., Cape of Good Hope. G. 72-'95 to G. 34-'07. Cape Times Ltd., Cape Town.

TENISON-WOODS, REV. J. E.: "Fish and Fisheries of New South Wales," Govt. Prtr. Sydney. 1883.

THOMPSON, W. WARDLAW: "Sea Fisheries of the Cape Colony" with chap. on Trout and other Freshwater Fishes. T. Maskew Miller, Cape Town. 1913.

TRAUTMAN, MILTON B.: *Trans. Amer. Fish. Soc.* Vol. 62, pp. 258-266, Wash. D.C. 1932.

A limited number of copies of the following papers can be sent to readers of this Journal who are interested in inland fisheries from A. Cecil Harrison, Inland Fisheries Advisory Officer, St. George's House, 73 St. George's Street, Cape Town. (Gratis, post free).

HARRISON, A. CECIL: "Progress report on the Acclimatization of Smallmouth Bass and Bluegills." Circ. No. 32, C.P. Socty. Nov. 1938.

..... "Witte River, above Bain's Kloof, Wellington," Circ. No. 33, C.P. Socty. June 1939.

..... 8th Annual Rpt., C.P. Socty. Cape Town. Aug. 1939.

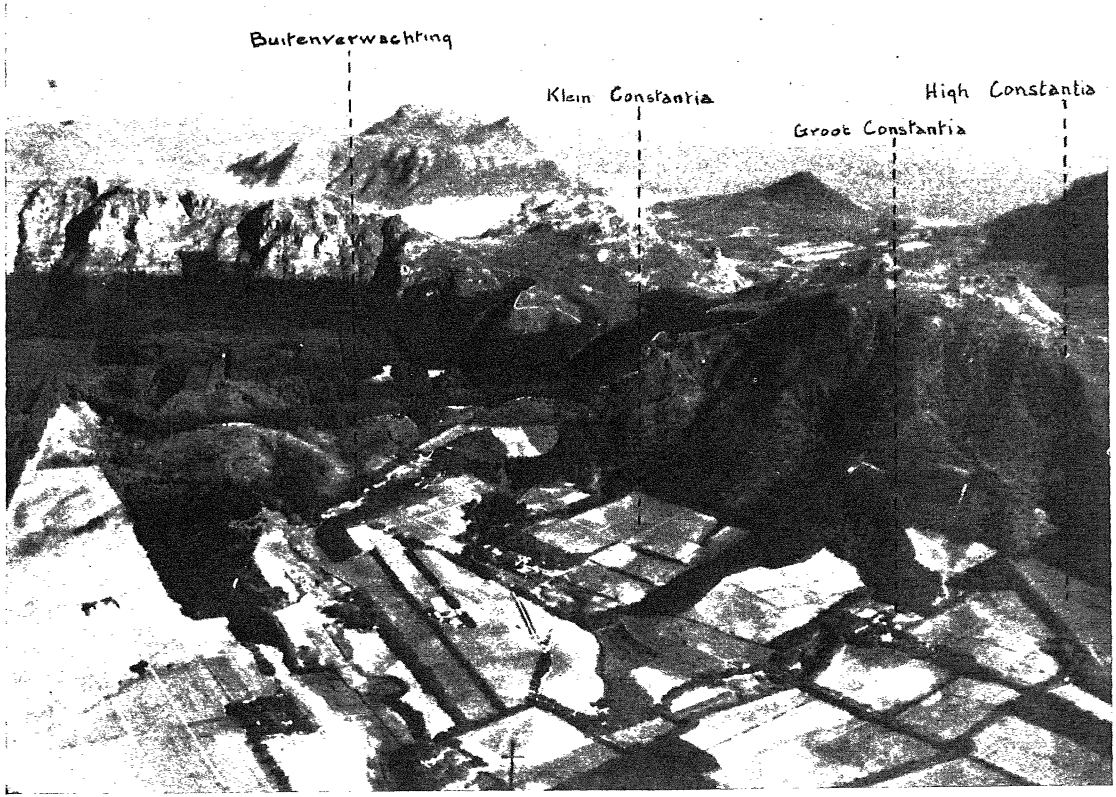
..... Rept. of Inland Fisheries Advisory Officer for Year 1938. Prov. of the Cape of Good Hope. Bilingual. 1939.

..... "The Importation of Spotted Bass (*Micropterus punctulatus*)" Circ. No. 34, C.P. Socty. Nov. 1939.

..... Rept. of Inland Fisheries Advisory Officer for Year 1939. Prov. of the Cape of Good Hope. Bilingual. In Press.

HEY, DOUGLAS: Circ. No. 35. C.P. Socty. March 1940.

Cape Provincial Notice No. 25, January 1940, Re Supply of Trout and Other Non-Indigenous Fish. Bilingual. Reprints from Official Gazette.



Constantia Valley from the air, looking West.

Cape Publicity Association.

RAINFALL AND STREAMFLOW AT THE CAPE

By J. D. M. KEET
(Director of Forestry)

A STUDY of the rainfall regime in the Cape Peninsula, in connection with the drying up of streams, and the receipt incidentally about the same time of a note by Mr. R. C. Burton, ex Conservator of Forests, on the influence of sun-spot rainfall cycles on the levels of the great lakes in Central Africa, was the immediate inducement for a somewhat hasty and superficial enquiry into the available evidence on weather forecasts for South Africa.

"Sunspots" Hutchins, as Sir D. E. Hutchins, F. R. Met. Soc., sometime Conservator of Forests at Knysna, was known to many colleagues and friends, was a great student of world meteorology. Knowledge thus acquired enabled him to introduce into South Africa many species of trees well-matched to the local conditions. Several of these have proved sufficiently successful to justify our hopes in a future for forestry in the Union.

A matter of equal concern and interest to him was the forecasting of seasonal variations in rainfall for the benefit of agriculture. In his "Rainfall in South Africa" (1897) and "Agricultural Weather Forecasts" (1898) he lamented the want of long-period reliable data on which to base such forecasts and discussed the reliability of forecasts made by him in 1888 for a period as far ahead as 1942.

In attempting cycle forecasts for South African rainfall Hutchins used:—

(a) The sun-spot cycle, calculated by Dr. Rudolph Wolf at 11.11 years mean;

(b) Meldrum's or the "mitigation," cycle with a mean of 12.5 years; and

(c) the storm cycle for which a mean of 9.5 years was taken.

He placed great weight on the coincidence of sun-spot cycle, which was held to influence more the Eastern Summer rainfall, with storm cycle, affecting more the Western Winter rainfall. These two cycles co-incided in 1850, a year of high rainfall and again in 1916, followed by Meldrum's cycle in 1917. The latter was regarded as an intermediate Eastern rainfall cycle. Except along the south coast where unprecedented floods occurred, the rainfall for 1916 was low; and that for 1917 high, almost throughout the country. It can be surmised that Hutchins would have explained this apparent failure of his forecast, and perhaps with justification, by allowance not having been made for accrual of the fraction in the length of the sun-spot cycle and through his taking the storm cycle at alternate 9 and 10 year intervals, instead of alternate 10 and 9 year intervals, which would have brought the three cycles to culmination in 1917. On the whole he was, however,

disappointed in the general unreliability of the sun-spot cycle, and was inclined to attribute its vagaries to discrepancies between precipitation in calendar and in hyetal years, which is an important consideration in analysing the incidence of a summer rainfall. The advantage presented later by the works of Sutton (1930), Plummer (1932) and Schumann and Thompson (1934) was then not at his disposal.

The reliability of Hutchins's forecasts in respect of an individual Winter rainfall station can be seen from the accompanying rainfall curve for the Royal Observatory on which the culmination of the respective cycles is shown. Unexplained inconsistencies are also revealed when the cycles are plotted on the smoothed curves prepared by Schumann and Thompson.

In having to work in his time on the records of individual stations Hutchins had to contend with the notable irregular distribution of our rainfall from place to place and season to season. We now have in Schumann and Thompson's work the Union, Basutoland and Swaziland divided into twenty-three rainfall districts based on similarity in the average monthly distribution, also Plummer's (1927) preliminary investigation into the reliability of the rainfall of the Transvaal, in which that Province is divided into eight hyetal regions based on the reliability of the mean annual rainfall, as well as his further work on similar lines on aspects of the rainfall in the Western Cape Province (1932). With the aid of these works an investigator like Hutchins might conceivably have achieved greater precision in his forecasts.

In discussing the question of climatic changes Schumann and Thompson maintain that since it had to be conceded that such changes have taken place over periods running into centuries within historic times, changes that are also clearly evident in South West Africa and along the South Coast of the Cape Province, it is logical to expect that changes of shorter period will also occur and draw attention in this connection to the pronounced secular trends of most of the smoothed rainfall curves prepared by them for South Africa and reflected also to a marked degree of coincidence in the rainfall of South Australia and New South Wales. But in dealing with weather cycles they are inclined to support the contention of D. Brunt (1927), quoted by them, that on the general question of periodicity in atmospheric phenomena the time had arrived to say that the movements of the atmosphere are so complicated that it is impossible for them to have any definite periods except such as are dictated by astronomical circumstances. They admit that the eleven years sun-spot cycle is reflected to some extent at least in the rainfall and other meteorological phenomena at certain points of the earth, but contend that beyond this the existence of weather cycles of fixed period and amplitude is highly problematical and find that the rainfall curves for the different South African rainfall districts show very little evidence of fixed periodicities.

If secular changes in rainfall within historic times are accepted, just as climatic changes within recent geologic times are, it may also be logical to expect still shorter period or cycle changes imposed on their secular curves. Since the latter reflect mean annual values for districts comprising stations having similar average monthly rainfalls, and as it is accepted that the annual precipitation recorded at any station may differ widely from that of any other station within the

district, it must be clear, especially in view of the admitted insufficiency of recording stations and the difference in length of time of the records, that we have as yet no true measure of the total amount of precipitation reaching the earth's surface during the hyetal year in any particular district of known extent, and thus for the region or the country as a whole. It would seem therefore that before the pronouncement with respect to short period changes can be permitted and the theory of weather cycles finally rejected a more comprehensive and more accurate assessment of the amount of moisture reaching the earth's surface each hyetal year is required. Until then final conclusions may not be warranted. There is full balance in nature and it may well be that deficiency or excess in one region is compensated by excess or deficiency in another, however distant in space and time. Unseasonal rains at the Cape are usually reflected in drought up country, and *vice versa*.

Hutchins following the observations of Elliott, Government Astronomer, Natal, on the influence of the Antartic ice on "seasonal" weather conditions in South Africa, stressed the need for data from New Zealand, Tristan d'Acunha and the Falkland Islands for daily and seasonal forecasts for South Africa, especially for the Winter rainfall. For Summer rainfall forecasts he suggested the study of the character of the south eastern trade winds in Australia and countries in the Indian Ocean and of the allied south west monsoon in India. On his observations on the behaviour of the south eastern trade winds in the Eastern Province he actually forecasted the drought and famine of India in 1896.

The value in many directions that reliable seasonal forecasts may have for the farmer in South Africa and what influence this may bear on the political economy of the country have often been stressed. Haylett (1930), however, in his study on rainfall and crop yields in the Transvaal came to the conclusion that their correlation is too low to serve as a basis of prediction. This lack of dependance of yield on potential rainfall is due to secondary inhibiting factors, such as run-off, mal-distribution and weed growth. Only the residue is "usable" rainfall.

Compared with agricultural crops, forest crops are less sensitive to fluctuations in surface moisture, but nevertheless reflect the same tendencies and seldom give a true expression of the total amount of annual rainfall. The results of attempts made in other countries to assess past climatic changes by measuring the width of growth rings of trees and of forecasts based thereon of cyclic weather changes will be accepted with reservations by South African foresters. Account must also be taken of variation from place to place in amount of precipitation during any single rainfall within the same district, even for a region, such as the Western Cape Province, which is popularly, although erroneously, held to have a fairly dependable weather regime, as also of the variation from year to year in the time of onset and of cessation of the seasonal rains.

Apart from what little evidence there is to be found from a study of the rainfall curves in support of definite rainfall cycles, and even if the further angle of approach here suggested may lead to more dependable forecasts, it is doubtful whether the result will prove to be of practical value to the agriculturalist, owing to the changeable incidence of the rainfall in each season and locality. For this reason

the Forester in South Africa has learned to appraise the growing site on the amount of the minimum annual, rather than on that of the mean annual rainfall, especially where short period records only are available, and also to avoid the snares, which the delusion of years of abnormally high rainfall so often lays for the agriculturalist.

The behaviour of springs and streams in the Cape Peninsula, particularly at Simonstown and in the Constantia basin during later years, has been related on many occasions. There is undisputed evidence of diminution, even of cessation, of streamflow in these localities and this, supported by the fact that trees, in view of their rapid transpiration of water from the soil, as occurs indeed with all forms of vegetation, have been used in conjunction with trench drainage to dry up shallow swamps in South Africa and elsewhere, has been cited as proof of the harmful effect the growth of exotic trees on the mountain slopes has on water supplies. In so far as the Constantia basin is concerned it will be seen from the accompanying Plate that the slopes of the mountain on the west are afforested to an appreciable extent. There are also remnants of indigenous bush in some of the kloofs. Individual streams in both forest and plantation hold no surface water during the dry months, whereas in other instances there are perennial springs in both.

The first record of irregularity in streamflow in the Constantia basin is in respect of the farm "High Constantia," now the property of Mr. Bertram, and is contained in J. C. Brown's "Effects of Forests on Springs" (1877) from which the following quotation is given.

> A case similar to that occurring on the Wolfspring was reported to me by Mr. S. van Reenen, of Constantia. The site of the celebrated vineyard so long in possession of his family, measuring some 45 acres, or 22½ morgens, was when granted to his forefather as a forest. There was then on it an abundance of water, such abundance that though there was no spring on the property there was a large reservoir and a large pond in front of the house, supplied and maintained by a stream of water, at least four inches in diameter. But when the forest was felled, and the vineyard planted in its place, the supply of water gradually diminished till it was reduced to a supply one inch in diameter, and ultimately to a supply measuring only a quarter of an inch.
>
> On the same ground he afterwards formed a plantation, to the destruction of which by fire I have elsewhere had occasion to refer.
>
> In regard to this he informed me that on the abolition of slavery, probably about 1838, he feared he should not be able to keep so much vineyard under cultivation as he had previously done, and he employed several of his slaves in sowing seeds of the Cluster pine and of the Stone pine (*Pinus pinaster,* and *Pinus pinea*). In one night specified by him to me as the night on which the "Vulcan" entered Table Bay with the German Legion, the wood thus formed was consumed by a fire, occasioned by one of his neighbours burning the bush on his farm, and I understood him to say that the effects were again the same : a somewhat copious flow of water, which had been re-established during the growth of the trees, was suddenly stopped by the denudation of the soil.

The exact year in which the forest on High Constantia was cut down is not ascertainable now, but as the plantation was established in about 1838 (slavery was abolished in 1833-1834) the plantation was only 18 years old when it was destroyed by fire in 1856, the year in which the German Legion arrived in Table Bay. At that age the plantation would hardly have created real forest conditions, and as the rainfall at the Cape was with the exception of one year, namely 1850, below normal from 1844 until 1856 the assumed relationship

between plantation and streamflow, although significant, must be accepted with caution.

Prinskasteel Stream at the opposite or southern end of the basin has a correspondingly irregular run-off regime. Others in the central part as well, but with this difference that some of them, whose waters are not wholly consumed by upstream riparian owners, still allow a small flow to lower farms during the dry summer months. The fact that some of the latter originate outside Tokai Plantation has given rise to the notion that this plantation has adversely affected the water-supplies.

Afforestation was begun at Tokai on the lower end of the southern portion in 1884 and was extended from there westwards to the 1,500 foot contour with the small projection above that level during the next 20 years and finally northwards during the period 1905-1913. Prior to this the land on the Tokai slopes of the mountain, rising to 3,000 feet, was leased to local farmers. Grazing and burning of the veld led to the formation of extensive dongas and it was partly to stop this erosion that the Forest Department was commissioned to undertake afforestation of the land.

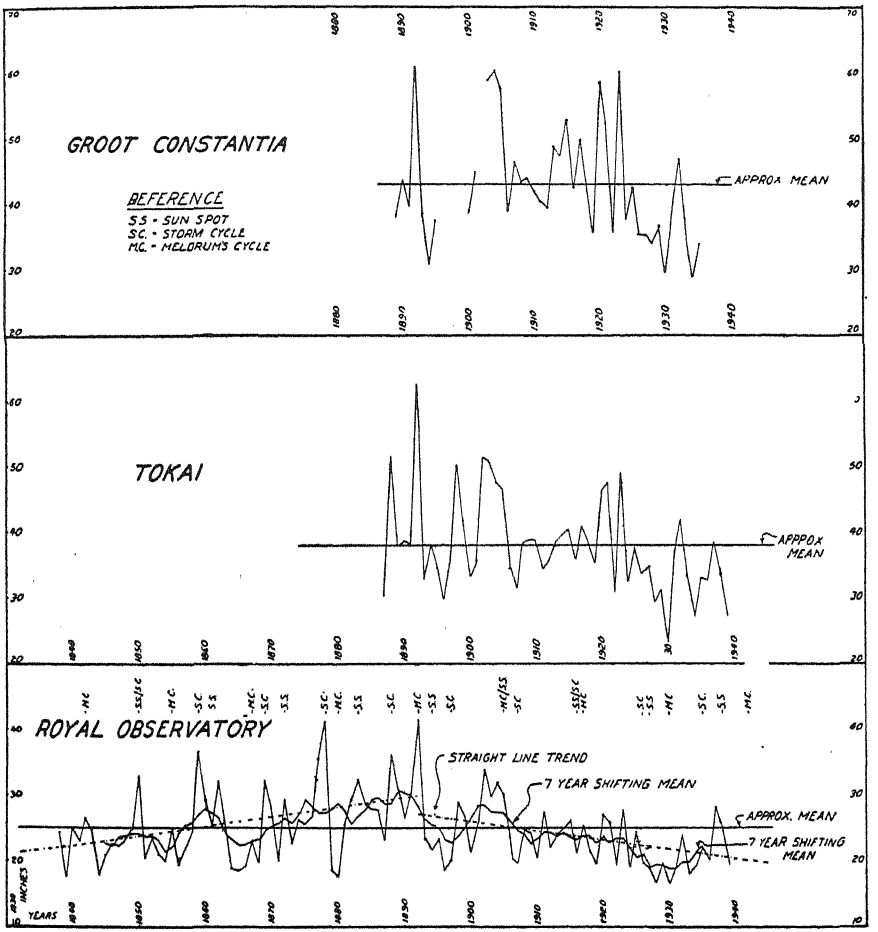


FIG. i.—Graphical representation of rainfall at 3 Cape recording stations.

For some years after afforestation was commenced the Prinskasteel stream, which has its main catchment on the mountain above the plantation and flows through the older southern part thereof, had sufficient water to permit of some irrigation on the low lying land on the reserve. The Elephant Eye Stream, again, to the north of the Prinskasteel, had then enough water to allow of it being piped for domestic use. The uper catchment of the latter system, like that of the Buitenverwachting system, is comparatively small and precipitous. Their water is supplied by soakage springs rising near the 400 foot level, in the case of the former inside, and in that of the latter outside, the planted area.

For the last 30 years or so the Prinskasteel and the Elephant Eye Streams have been intermittent, except occasionally in years of above normal rainfall, while these lower springs in the Buitenverwachting area have decreased considerably in volume of flow. In the Prinskasteel, Buitenverwachting and Klein Constantia Streams there are, however, small springs rising at about the 800 foot level, both inside and outside the plantations, that have remained constant throughout.

The variations in streamflow in this locality can therefore not be ascribed to the effect of the plantations, notwithstanding the evidence adduced by Brown in the case of High Constantia that the parentage of the spring lies in the tree that shades it. The effect of rainfall on streamflow cannot in this instance be ignored.

The "straight-line" and "shifting-average" curves for the rainfall at the Cape shewn in the accompanying drawing* clearly shew the definite secular trend found by Schuman and Thompson, who stated that the peak rainfall period of the 1870's and 1880's has not occurred since in any locality. There is in fact an unmistakable upward trend from below average in 1838, the first available record, culminating in 1892, and as unmistakable a downward trend from that year to below average at the present time. In fact during the last 33 years the rainfall for this locality has with the exception of nine intermittent years been consistently below average. Where the origin of the straight-line rising curve lies before 1838 cannot be ascertained in the absence of authentic rainfall data, and speculation on the ending of the present falling curve is not permissable.

Tokai Plantation was therefore begun during the unusually long period of above average rainfall, when Prinskasteel Stream was perennial, whereas now it is intermittent flowing only during the winter rainy months. It is not known whether the streams in the northern part of the reserve were ever perennial in flow inside the plantation, apart from swampiness in a few places. They were definitely dry in the early summer of 1906.

Confirmation of the relationship between amount and incidence of rainfall and streamflow is now forthcoming in several cases where weir readings are available for both forested and non-forested catchments, but the presentation of the data must be deferred for a later occasion.

---

*Prepared by A. Jurriaanse, B.Sc., Agr. B.Sc. Forestry.

THE BANTU AS FOREST BOTANIST

By O. B. MILLER

(Forest Officer for Bechuanaland Protectorate and Swaziland)

THE value of native names as a help in identifying plants is gradually decreasing. Whereas so recently as from ten to fifteen years ago in many parts of Southern Africa any native would unhesitatingly give a correct vernacular name, this pleasing state of affairs is disappearing, and the reason for it is the increasing number of schools. The rising generation takes more pride in being able to state the year in which Julius Caesar or William the Conqueror landed in England than in knowing his trees. Once it was thought shameful as well as a handicap not to know a particular tree, shrub, or herb. To-day it is counted shameful to know them. Only "shenzis"—wild people—do that. This unfortunate attitude is likely to persist until education authorities persuade their pupils that a knowledge of the indigenous flora and fauna is not incompatible with culture. Otherwise the recording of vernacular names by plant collectors is likely to become of more consequence to the etymologist than to the botanist.

The native who lives on the almost treeless plain has naturally a very poor knowledge of, say, high forest species. He is like the London taxi-driver on being confronted with a Scots pine, and asked to give its name. The latter would probably recognise a hazel tree if it happened to be in fruit. A walnut tree might, and the Scots Pine almost certainly would, stump him. Similarly the native's knowledge would be confined to plants which give him a medicine, or edible fruit, or spear shafts, or axe handles, or particularly bad firewood, though his wife would probably be more knowledgeable as regards the last-mentioned. For the whole community to be well up in the local flora, it must live among it and be intimately dependent on it, like the Bechuanaland Bushmen and Masarwa, hunters rather than agriculturists. Or it must live like the coast Pondos, in a land where every ravine carries its fringing forest. Or in the great savanna woodland which extends from upper Zululand to Tanganyika Territory. In Swaziland, the comparatively primitive inhabitant of the bushveld is a good botanist, but his brother of the western hill country is not.

Fortunately schooling on existing lines has not yet spread over the whole of southern Africa, and there are still a number of tribes who 'know the trees." And this knowledge does not consist merely in memorization of a long list of uncorrelated names, but often shows a recognition of the relationship between members of the same genus, based generally on similarity of fruits. For instance, the similarity of the trifoliate leaves of the genera *Rhus* and *Allophylus* causes the Bantu botanist no confusion.

I remember once asking a native Forest Guard at Ntsubane in Pondoland the name of *Phyllanthus cedrifolia* Verdoorn. This tree was at that time unknown to science. His reply, translated, was, "I have

not seen this tree before, but one would say it is a relation of *Heywoodia lucens* Sim." He was right, for they both belong to the *Phyllantheae* tribe of the *Euphorbeaceae;* but while *Heywoodia* is a big tree with dark simple foliage, *Phyllanthus* is a slender small tree with pale pinnate leaves. The diagnosis was based solely on the fruit.

Native vernacular names change with the locality to a much greater degree than do the English and Afrikaans. This is particularly noticeable in Northern Rhodesia, where there are many different language groups. But in the Nguni group, the names for wild olive, sneezewood, and *Trichelia emetica* Vahl, persist almost unchanged from the Eastern Province of the Cape to Zululand and Swaziland. "Um-Tomboti" for *Spirostachys africana* Sond. persists from Pondoland in the Cape through Zululand, Swaziland, and parts of Portuguese East Africa, to central Bechuanaland Protectorate: the longest range of an unchanged native tree name that I know—eight degrees of latitude and seven of longitude. "In-Tshitshi" (*Leucosidea sericea* E. and Z.), from the north eastern Transkei to Basutoland, though of much shorter range, is used in the two different language groups, Nguni and Sotho.

When the ear is greeted by a familiar name, last heard a thousand miles away, it is usually a label for a totally different plant. "Elephants' Ears" is Swazi for *Pterocarpus rotundifolius* (Sond.) Druce, but isi-Xosa for *Trimeria grandifolia* (Hochst.) Warb. "Um-Zimbite," isi-Xosa for *Milletia caffra* Meisn., in the Nsenga language of Northern Rhodesia represents *Gymnosporia senegalensis* (Lam) loes.

The *Brachystegia,* that genus of many species, is peculiarly puzzling to the trained botanist. Many species have not even yet been satisfactorily distinguished. Systematists distinguish between several species by differences in the deciduous stipules of the plants which unfortunately seldom survive the journey to the ultimate authority at Kew. Although the genus presents difficulties also to the native, he at least was in advance of the academician in differentiation between its species and those of *Isoberlinia,* though probably not for floristic reasons, and has bestowed the name "um-" or "mu-Tondo" on several species of that genus in the Katanga district of the Belgian Congo, in Northern Rhodesia, and in the Chobe district of the Bechuanaland Protectorate.

The "in-Tozane" provide an interesting example of the native's intuitive conformity to scientific plant classification. Among all the many yielders of fibre, this name, in their language, is reserved for the *Thymeliaceae,* and includes shrubs so different in outward appearance as *Peddiea africana* Harv., a glossy, broadly lanceolate leaved shrub, and the heath-like *Passerina.*

The native name is often startlingly descriptive, often much more so, especially to the field botanist, than the *Smithii's* and *longipedunculata's* of the systematist. "Spoil the axe" and "turn the axe" for some very hard wooded tree. "Elephant's tusk" for a white stemmed tree. "Stink" or, alternatively, "smell of the striped field mouse" for *Clausena inaequalis* Benth. is one up on the academic systematist, for this species and *Hippobromus pauciflorus* (L.) Radlk have been confused, and the "smell" name has been attached to the wrong species. There is a Rabelaisian touch in the Sikololo name for *Albizzia rhodesica* B. Davy, a tree with a strikingly smooth, skin-like bark—"princess's backside."

It is strange that two large and locally well-known trees, black stinkwood and assegai, should—if one excepts the scarcely used "um-Nukani" of the eastern Transkei, for stinkwood—have no native vernacular names, corruptions of the Afrikaans equivalents being used. Assegai, it may be mentioned in passing, does not, as the name suggests, provide wood for the native throwing spear.

A word of warning to collectors in Bantu countries may not be out of place. Do not ask a native "Is this so and so?" Rather, "what is the name of this plant?" Be careful, moreover, not to write down under the heading, "Native Name," the equivalent in seSutu or chi-Bemba or other native languages for "I do not know."

THE MANUBI FOREST

By N. L. KING

(Chief Management Officer, Division of Forestry)

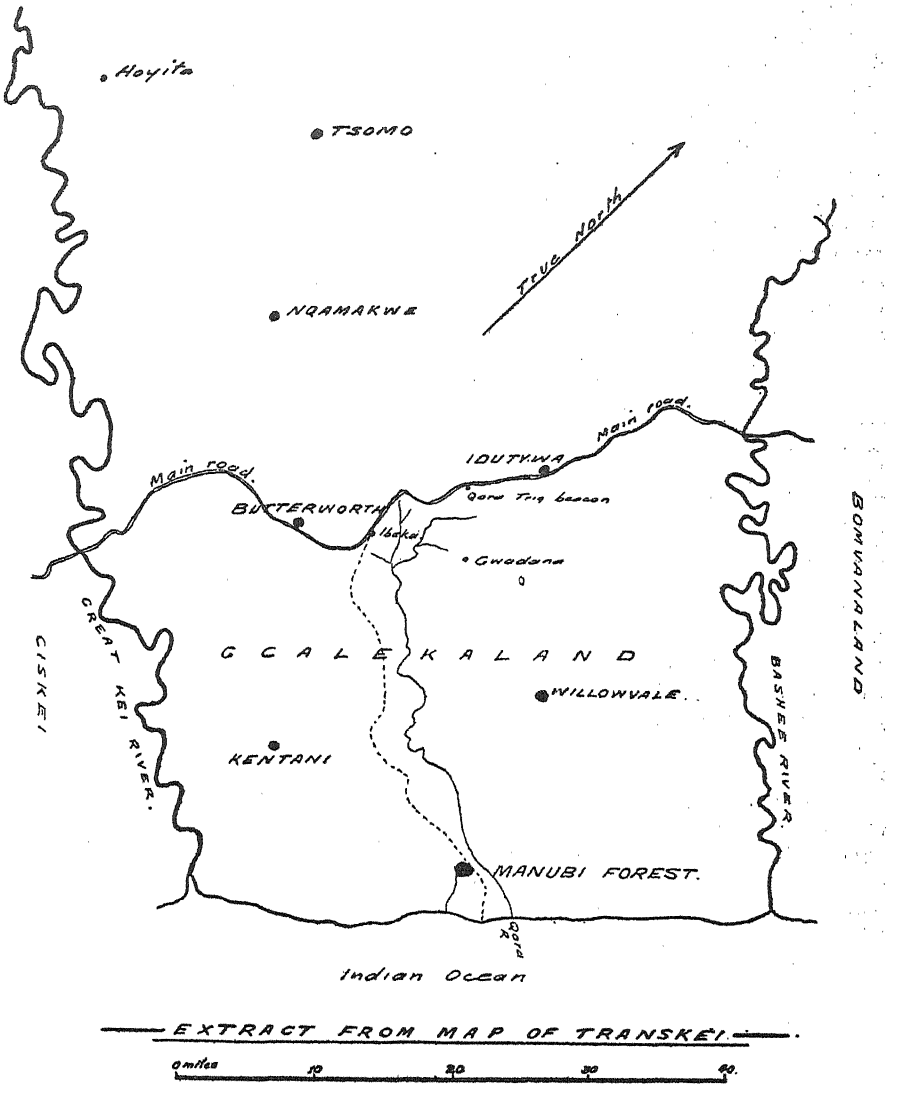
THE MANUBI forest is situated between the Qora and Ngqwara rivers in the district of Kentani, Transkei, at a distance of about three to four miles from the sea. This forest is of much higher quality than any other in the whole of the Transkeian coastal belt except perhaps portion of Mpame in the Elliotdale district and Ntsubane in Eastern Pondoland. Its high quality is due to exceptionally good soil conditions coupled with an adequate and fairly well distributed rainfall. About two-thirds of the forest is situated on rich doleritic soil as much as thirty feet deep in places. The remainder is on soil derived from the Beaufort shales. The latter is not nearly so favourable to tree growth and consequently the forest it carries is of relatively inferior quality.

Unlike the midlands and uplands of the Transkei where about eighty per cent. of the precipitation takes place from October to March, the costal belt enjoys a more evenly distributed rainfall. This is particularly the case at Manubi where, according to rainfall normals, no month of the year has less than two inches; while of the average annual precipitation of forty-eight inches, forty per cent. occurs in the so-called dry season from April to September. Further, the effective amount of the rainfall is high on account of the gentle slope on which the greater part of the forest is situated.

The winter months at Manubi are mild, in fact so mild that sub-tropical plants such as paw-paw, banana and the tender shrub called Frangipani (Plumiera) can successfully be cultivated.

Although Manubi forest is close to the sea and only about 300 to 600 ft. above sea level, it contains a number of tree species which are usually confined to the mountains. It also contains several outliers of sub-tropical flora. At least forty-five tree species are represented. As far as the writer is aware an authoritative list has not yet been compiled and should, as a matter of interest, be taken in hand. Laughton, Research Officer, in an official report stated that "the large number of sub-tropical species in this forest and the difficulty in finding out the identification of many of the species made it rather puzzling to me. The names by which the trees are known did not, for the most part, occur in Miller's list of Kaffir names, and they appear to occur in no other forest." The more important trees include common and upright yellowwood (*Podocarpus falcatus* and *P. latifolius*), ironwood (*Olea laurifolia*), sneezewood (*Ptaeroxylon obliquum*), Cape mahogany (*Trichilia emetica*), red stinkwood (*Pygeum africanum*), Cape teak (*Strychnos Atherstonei*), hard pear (*Strychnos mitis*), white pear (*Apodytes dimidiata*), Cape chestnut (*Calodendron capense*), and Cape box (*Buxus Macowani*).

The actual area of the forest, according to a recent survey, is only 1,726 acres. Henkel, Conservator of Forests, in his annual



Map showing position of Manubi Forest.

report for 1888 stated that "this forest has been strictly preserved from destruction by Kreli until his expulsion and the locating of Gaikas and Fingoes in Gcalekaland. Now the area has been considerably reduced through fires and the conversion of forest land into mealie gardens." As we shall see later, Kreli was deposed in 1878 and any destruction which may have taken place must have occurred between 1878 and 1888. There is, however, no evidence on the ground to-day to indicate that the forest ever extended beyond its present limits except perhaps to a small extent at one or two points on the northern side. In the same report Henkel also stated that "the forest shows distinct zones as regards timber trees." The highest was represented by

Trichilia and *Podocarpus*, and the lowest by *Buxus*, *Milletia* and other species, which generally occur on the drier ridges and slopes. The differentiation into three zones would be difficult to justify at present and the most that could be said is that two types of forest are met with, one on the doleritic soil and the other on the shale.

All accounts agree that before exploitation took place the Manubi was a magnificent forest. It is said it consisted mainly of large trees through which a man on horseback could ride. To-day jungle growth is so dense that it can hardly be penetrated even on foot. Lister, who reported on the Transkeian forests in 1892, stated "the Manubi contains some remarkably fine timbers. The trees are loftier than those in the Colony and there are several valuable species not found westwards of the Great Kei river. The *Trichilia dregeana* (*emetica*) is especially conspicuous for its loftiness. It towers upwards of 100 feet in height and its dense and handsome foliage gives to the forest a distinctive character." Heywood, a few years later, mentioned that both species of yellowwood were found of very great height, clean boles of forty-five feet being not uncommon. A woodcutter informed the writer that many of the yellowwoods measured at least five feet in diameter at breast height. Records of six sneezewoods gave the yield of timber from these trees at 777 cu. ft. or an average of nearly 130 cu. ft. per tree.

The Manubi was one of the few forests near the coast which contained yellowwood in appreciable quantities. As this timber is the most useful of our indigenous woods for building purposes, it is not surprising that, shortly after the annexation of Gcalekaland in 1884, the forest received attention by timber getters. Exploitation was probably commenced by hand sawyers and pole splitters but it was not until 1890 that working was commenced on a large scale. During that year the late Mr. Trow established a sawmill in the forest. This mill, after its enlargement in 1896, was considered to be the most efficient in the Eastern Province. It functioned continuously for 14 years except for an interruption in 1897 caused by the enormous losses of cattle from Rinderpest and again in 1900 when the mill staff was called out for active service during the Boer war. According to Lister the products turned out comprised planks, beams, match boards, ceiling and wagon woods and an immense number of pickets or paling for the East London market. The mill also supplied the Frontier with table and chair legs besides axe and pick handles of a quality said to be incomparably superior to anything of the kind imported. In 1904 the mill was completely destroyed by fire and was not re-established. It would, at any rate, have had to close down a year or two later as, with the exception of one section, Manubi forest had been worked out and supplies of wood of the kinds required were not available from any other forest in the neighbourhood.

The total quantity of wood extracted will never be known as records are not available prior to 1898. Between 1890 and 1904 the quantities extracted are recorded as follows:—

Yellowwood	88,494 cu. ft.
Sneezewood	4,166 cu. ft.
Ironwood	7,477 cu. ft.
Other species	23,916 cu. ft.
Total	124,053 cu. ft.
Average annual quantity	17,722 cu. ft.

Of this quantity roughly 50 per cent. was derived from common yellowwood and 21 per cent. from real yellowwood. No information is available as to the woods included in "other species," except a reference to white pear, white milkwood and Cape teak. It would, however, probably be quite safe to include assegai, Cape chestnut, essenhout and Cape mahogany. If we take the average annual cut at 15,000 cu. ft. the quantity of wood yielded by the forest would be in the neighbourhood of 210,000 cu. ft. or a little more than 120 cu. ft. per acre.

After the last section was worked in 1905, the forest was closed except for dry and windfallen trees and a little Cape box at odd times. It is of interest to note that Manubi boxwood is smaller than that found eastwards, but is said to be of better quality on account of less black heart. It will be noticed that of the forty-five or more tree species contained in the forest, only about ten were in demand and that, of the entire cut, no less than 71 per cent. was derived from the two species of yellowwood. Although the general principles of working a forest were to mark for felling only damaged and fully mature trees, to avoid making large openings and to preserve sufficient seed bearing trees, these principles seem to have been thrown overboard at Manubi where a clean sweep was made of practically all yellowwoods of marketable size. As Caplen, District Forest Officer, tersely remarked "the forest is finished for a long time so far as yellowwood is concerned." The same remark could safely be applied to sneezewood as well. It would probably not be wide of the mark to say that neither yellowwood nor sneezewood will again become available from Manubi for well over a century except in very insignificant quantities. The removal of almost all large yellowwood has not only lowered the general height of the forest, but has profoundly altered its character. The less valuable but more aggressive species have been given a decided stimulus to assert themselves and are now occupying the soil to the detriment of the better kinds. Although the cut was, as far as can be ascertained, only in the neighbourhood of 120 cu. ft. per acre, it would appear that a considerable amount of damage was caused by the fall of large crowned trees and by the extraction of logs. The openings thus created have since been closed up by dense thickets in which competition for growing space is much too intense and should be relieved by thinning. Although these thickets may contain yellowwoods, it is questionable whether the latter will ever reach a large size, for in every forest where heavy fellings have been made, there is a tendency amongst yellowwoods to become stagheaded at an early age with poor height growth.

What treatment Manubi forest should now receive cannot be stated until figures are available from the stock taking that is to be carried out. In most parts sufficient regeneration of the more desirable species seems to be present. If this is borne out by the stock taking all that appears to be necessary at this stage is to thin out the thickets by favouring the better species, cut back creepers, fell or destroy decayed trees and get rid of species of no known commercial value, except in places where they may be required to keep weed growth in check.

And what moral is to be drawn from the story? Leaving aside the annihilation of the yellowwoods, it is obviously unsound to single out for felling a few species only and leave the others to take possession

of the soil. This system of working must ultimately lead to the degeneration of any mixed forest. Sound forest management demands that marking should be carried out on purely sylvicultural lines and not with an eye on species which happen to be in demand. In order to carry this principle into effect many difficulties have to be overcome and it is here that Research must come to the rescue. The first step is thoroughly to investigate the properties of woods which cannot be disposed of locally, in order to determine the use or uses, if any, to which they may be put. These investigations should be followed by service and marketing tests. We would thus be in a position to distinguish between species of economic value and those which should be regarded merely as an encumberance and which should accordingly be eradicated. It would then be a comparatively simple matter to determine whether the exploitation of any particular forest could be justified on economic grounds and to follow up exploitation with cultural measures designed to ensure the maintenance of the more desirable species. A commencement in the direction indicated has already been made with the dispatch to the Forest Products Institute of trial shipments of many Transkeian woods which are unsaleable locally. If markets can be found for these woods in the form of manufactured products, the treatment of forests which have practically been denuded of the more desirable species will be considerably simplified.

Before concluding this sketch, it may be of interest briefly to review the movements of Kreli who is supposed to have preserved Manubi forest up to the time of his deposition. In 1838 he became Supreme Chief of the Gcalekas and an offshoot called the Gaikas who occupied the territory between the Bashee and Great Kei rivers from the sea to a considerable distance inland. His "Great Place" was situated at Hoyita, about 15 miles south west of Tsomo and, as the crow flies, 65 miles from Manubi.

After the cattle killing episode* in 1856 at the instigation of a witch doctor named Nongqause, the Gcalekas and Gaikas rose against the Europeans, but were defeated. Kreli fled across the Bashee into Bomvanaland and established his kraal at a place called Mgazana. He was forgiven in 1864 and allowed to return, but his territory was limited to the area south of the main road between the Bashee and Great Kei rivers. To this tract the name of Gcalekaland has since been restricted.

Kreli then established his "Great Place" on the Qora river at a spot about 10 miles north east of Butterworth. This spot, in a direct line, is roughly 25 miles from Manubi.

In 1877 the Gcalekas and a section of the Gaikas again rose against the Europeans and sharp engagements took place at Gwadana and Ibeka, both of which are now forest reserves. The decisive action was fought at Kentani in 1878 when the power of the Gcalekas was

*The natives were commanded by their chiefs to kill and eat their cattle, to destroy their corn and to leave their lands uncultivated. They were told that on an appointed day their cattle would rise again, sleek and fat, corn would appear ready for cutting, dead warriors would come to life and the white man would be driven into the sea. On the appointed day nothing happened except that the natives were faced with starvation. Government provided food for their relief.

finally broken. Kreli once more fled across the Bashee and was proclaimed an outlaw. His territory was formally annexed by the Cape Government in 1884.

From this review it will be seen that from 1838 to 1856 Kreli's "Great Place" was 65 miles from Manubi, from 1856 to 1864 he was a fugitive in Bomvanaland and from 1864 to 1878 his "Great Place" was at Qora 25 miles from Manubi. It is therefore difficult to understand why he should have singled out for protection a forest so far from his headquarters. The only explanation that has been given is that it was set aside as a hunting domain for the Royal entourage. This seems unlikely on account of the distance between the "Great Place" and Manubi and also because game abounded in forests much nearer at hand. If the story is correct the most feasible explanation seems to be that, on one of his excursions to the coast, Kreli, who had certain good qualities, was impressed by the magnificience of the forest and ordered that it be preserved. An order from the Supreme Chief would have been strictly observed through fear of the dire punishment that would follow disobedience.

Whether the legend has any foundation or not, the fact remains that in 1878 the Manubi was a magnificient forest but has been much impaired by the exploitation which took place between 1890 and 1904. The task that lies ahead is gradually to clean up and rebuild the forest.

DEVELOPMENTS IN PATHOLOGICAL RESEARCH ON WATTLES

By M. S. J. LEDEBOER

(*Phytopathologist, Division of Botany and Plant Pathology, Pietermaritzburg*)

THIS paper is a review of work done in wattle diseases since the writer's appointment in the Division of Forestry in November, 1938. The experimental work, which was preceded by a general survey of the Wattle districts of Natal and of the Piet Retief area of the Eastern Transvaal, was carried out on a temporary basis until August, 1939, since when it became possible to start experiments in a special laboratory equipped by the Division of Plant Industry (now the Division of Botany and Plant Pathology). As many of the experiments have been of a purely temporary nature, few definite results have so far been achieved. Working with trees is long term work, and in the case of the present investigation, the physiological background, so necessary to pathological investigation, was at inception entirely lacking. In the course of the work so many aspects, even as regards individual diseases, disclosed themselves that it has been difficult at times to decide which to pursue, and thus the slow progress inseparable from scientific research has been accentuated.

Wattle diseases so far observed have been described in a preliminary report by Stephens and Goldschmidt (1939), and the microscopical appearance of gummosed bark, by van der Byl (1914). Van der Byl's observations have been confirmed by the writer by examination of sections cut through diseased bark at various stages of gummosis. The difference between healthy and diseased bark is illustrated in photographs 1 and 2.

Of the diseases discussed by Stephens and Goldschmidt, investigation of bagworm and froghopper is now in the competent hands of the Cedara entomologists; while eelworm seems to be of only minor importance. Some bad cases of the last mentioned have been observed, high mortality amongst six week old seedlings occurring in one instance; and although the presence of the nematode appeared to enhance the susceptibility of the plants to attack by a fungus (*Phoma*), a considerable number survived, and no trouble has been reported since. For these reasons, the three diseases mentioned have been regarded as falling outside the scope of the present study, which is accordingly confined to gummosis, Albert Falls disease, and collar rot.

Gummosis

Preliminary Considerations.

Available literature on gummosis phenomena in plants other than wattles, such as *Prunus* and *Citrus* species, discloses a number of possible causes of the condition. In *Citrus* for instance it may be due

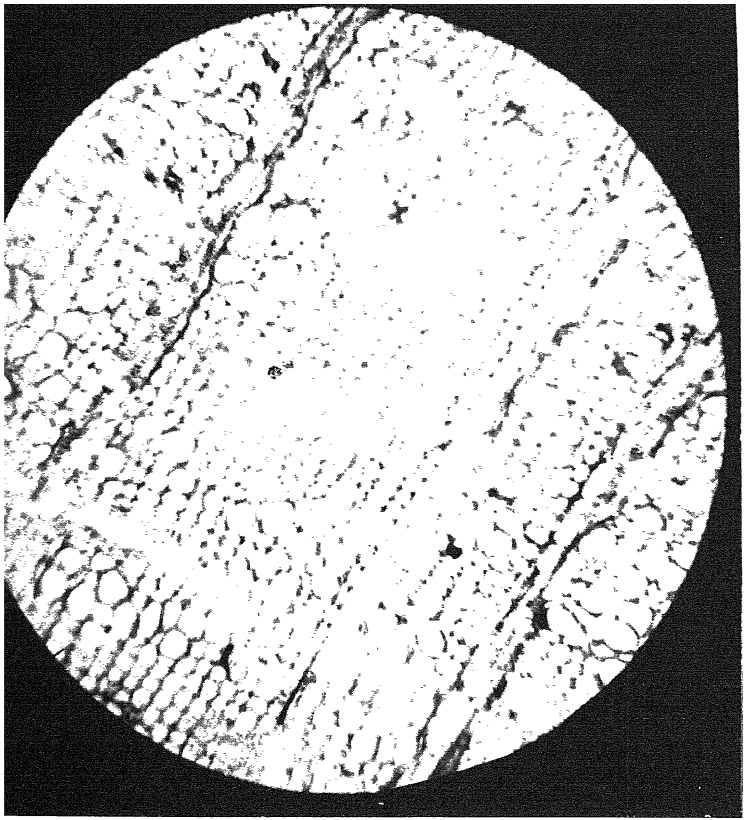


FIG. i.—Cross section through healthy wattle bark.

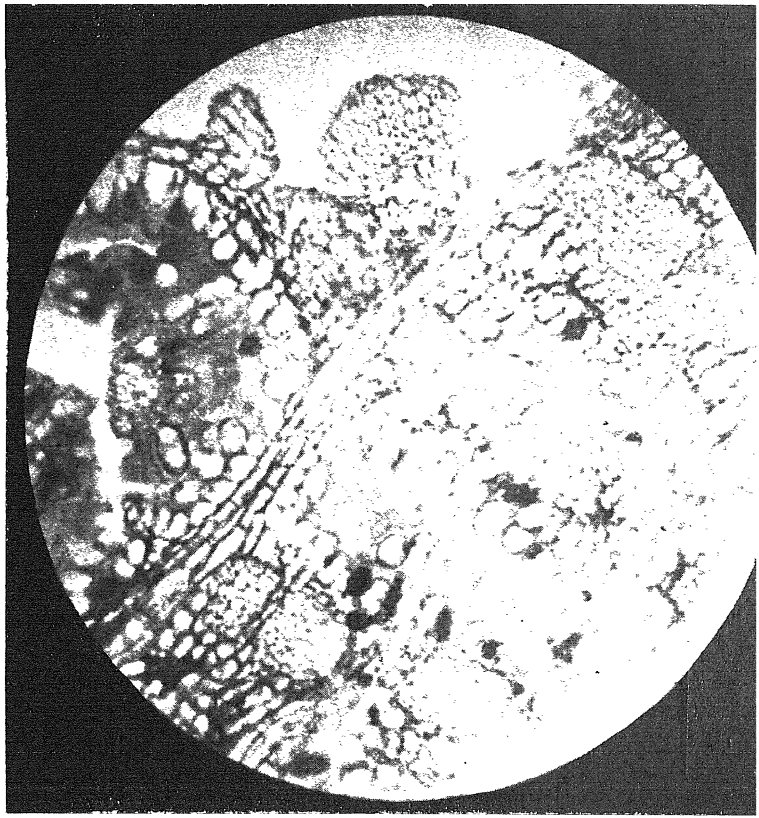


FIG. ii.—Cross section through "gummosis" bark. Compare w
fig. i. Most of the parenchyma has been replaced by gu



FIG. iii.—Set 3 after three months' growth. Pure sand. Tin covered with paraffin.

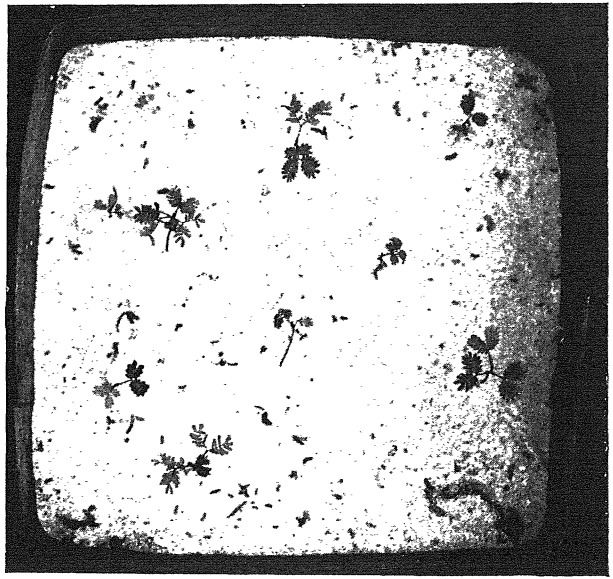


FIG. iv.—Set 5. Particulars as in fig. iii.



FIG. v. Root nodules in set 5. Builders' sand.

to either of the parasitic fungi, *Dothiorella* (Savastano 1932) and *Phytophthora* (Toxopeus 1932 and Ahmed Sirag-el-din 1934); to a virus (Fawcett and Klotz 1938); or to Boron deficiency (Haas and Klotz 1931). The necessity therefore in a study such as this of investigating every phenomenon that can be associated with the presence of the disease amongst wattles is obvious. Its cause may be either external, internal, or both. Amongst external conditions may be type and depth of soil, each as affected by varying degrees of humus content; sylvicultural treatment; rainfall; hail; light; and temperature. Internal causes may be associated with age, branchiness, rootform, and symbiotic relationships, such as presence or absence of mycorrhiza or root nodules. Of these conceivably possible causes analysis of data from seventeen different localities eliminates humus content of the soil, root development and branching, mycorrhiza, root nodules, and depth of tap root. In regard to the last mentioned, this was in more than one instance traced down in severely affected trees as far as 40 feet without exposing its extremities.

So far as soils are concerned it appears that all really badly gummosed areas are situated on shallow soils, or on soils that are more or less sandy. Sylvicultural treatment certainly exerts some influence, as the condition has never been observed in so-called jungle plantations, that is, in plantations where trees are stunted both in height and diameter. Prevalence of weeds seems to have no effect.

The predominating influence of rainfall was noted by Stephens and Goldschmidt (1939). In dry periods or on dry sites gummosis does not occur. This explains the rarity of fresh gummosis before the advent of abundant summer rains. The correlation of fresh gummosis with recent local rainfall is undeniable. Rapid drying off of surface soil, however, seems to have no effect. Withering due to drought is easily distinguished from gummosis. As a matter of fact this amazingly dry condition of the surface soil occurs both in diseased and disease-free plantations, often within 24 hours of heavy rainfalls. The condition is apparently due, amongst other factors, to the ability of the mat of surface rootlets to take up all precipitation immediately.

Hail wounds, during healing, bear some resemblance to old gummosis spots, but their distribution on the tree is different. They are readily distinguished from fresh gummosis. In regard to age, the findings of Stephens and Goldschmidt are confirmed, namely, that while most prevalent on trees from two and a half to five years old, trees of any age, from a few months up to many years, may be affected.

Selection of Lines of Research.

The positive reaction of wattle trees to excessive rainfall and particular soil types suggests certain mineral deficiencies as a possible cause of the disease. Parasitism or soil trouble are irreconcilable with the fortuitous manner in which infection is distributed amongst the individual trees of a plantation. Parasitic diseases usually spread from well defined centres, while reaction to unfavourable soil conditions usually manifests itself in diseased patches, plots, or parts of plantations. It is inconceivable that any pathological agency could exert its influence so fortuitously as the occurence of gummosis amongst wattle trees with their closely interwoven roots. One can only conclude that individual trees are endowed with peculiar degrees of susceptibility. Nevertheless

the possibility of parasitic influences should not be disregarded, and isolations should accordingly be attempted.

If in the course of these attempts, any particular organism constantly recurs inoculation experiments will be necessary to establish its pathogenicity. Allowing for the possibility that the pathogen might be a virus, bark grafting experiments would have to be undertaken immediately. Positive results yielded by such experiments would not necessarily justify identification of the pathogen with a virus, but they are the only means whereby virus manifestation can be secured.

To test the influence of mineral deficiencies, the food requirements of wattle trees must be investigated by means of extensive sand and solution culture experiments. Meanwhile, injection of certain chemicals as commenced by Stephens and Goldschmidt, as possible cures, should be continued.

The importance of root nodule bacteria to wattle trees is not at all clear. Every wattle tree has at least a few nodules, but the number on individual trees varies greatly, and it is not at present known whether the trees really derive any benefit from them. As with other plants the output depends largely on the strain of the nodule bacteria present, and this point accordingly demands investigation.

The lines of research suggested by the foregoing investigations may be briefly recapitulated as follows:—

1. Isolation of parasites in diseased bark.
2. Testing by inoculation the pathogenicity of any constantly recurrent parasite.
3. Determination of the nutrient requirements of wattle trees.
4. Isolation of root nodule bacteria, and investigation of their functions.
5. Inducement of vegetative propagation of wattles with a view to reproducing strains of known susceptibility or immunity for provision of dependable material for further research on above lines.

Work done up to time of writing in each of the above directions will now be described seriatim.

1. *Isolation of Bark Parasites.*

Pieces of bark taken from fresh gumming areas were disinfected by means of four per cent. formalin or .1 per cent. corrosive sublimate solution, mostly for two minutes, and after rinsing with tap water of proved sterility, laid on nutritive media in Petri dishes. Most of the pieces were cut in halves so as to expose fresh surfaces to the media. The media consisted of plum or cherry agar (pH about five). Sometimes different substances were used, such as oatmeal, mealiemeal, or peptone-glucose agar. When no growth appeared the dishes were retained for a month before being recorded as sterile.

Twenty-one samples were collected from eight different localities in December, 1938, and January, February, March, and April, of 1939. From these samples 202 pieces of bark were cut and placed in the agar. Seventy-seven of these pieces disclosed no organisms. From the remaining 125 pieces, nineteen different fungi were isolated from

111, and two or three bacteria from 29. The discrepancy in these numbers is due to fifteen pieces from which more than one organism was isolated being counted twice. The counts disclose no constantly recurring isolation. From the 77 most homogeneous pieces, 71 yielded no organism. From fourteen of them, one bacterium, and from another eight, one fungus were isolated, the host pieces overlapping as before.

The high proportion of sterile pieces amongst the more homogeneous ones is striking. As a matter of fact the numbers compare favourably with a sample of healthy bark, in which three out of nine pieces developed fungi. Most of the isolated fungi must therefore be considered as contaminations by saprophytes from outside the bark, which only very careful cutting could exclude.

Of the organisms concerned, one bacterium was isolated regularly from twelve pieces cut from one sample. From 30 out of the 46 pieces constituting four samples collected on one day in the same plantation, a species of *Pestalotia* was isolated.

Greig Smith (1902) states that some bacteria, including one isolated from gumming wattle, are capable of producing gum. He maintains that the masses of gum produced by *Acacia* are not the product of metabolic processes of the tree itself, but are caused by bacteria. He did not, however, perform any inoculation experiments to prove this or even to demonstrate that gummosis can be induced by inoculation.

The bacterium isolated in these experiments may be identical with one of those recorded by Smith. As it produced gum, and otherwise corresponded with his description of *Bacterium acaciae,* an attempt was made to identify it by his method of nutritional experiments on agar media containing asparagin as a source of nitrogen, and potassium citrate and different sugars as sources of carbon. Most of the characteristics of *Bacterium acaciae* were revealed, but as one was absent even after repeating the experiment in the same seven media, the identity of the bacterium must be considered doubtful.

Fungi of the genus *Pestalotia* are considered as being mostly saprophytes or wound parasites. The fact that this fungus was isolated only from material collected from one plantation on a single occasion, renders its pathogenicity improbable.

So many of the remaining organisms were isolated from single samples, and so few recurred in different samples that it was not considered worth while trying to identify them.

Although the external and microscopic appearance of the tree roots was normal, it seemed of interest to see whether any striking feature would arise from examination of the microflora on or in them, and eleven root samples were accordingly treated similarly to the bark. Six originated from healthy and five from affected trees, yielding in all 165 pieces. A large variety of organisms was isolated from each sample, but the strong similarity between those isolated from healthy and affected trees taken in conjunction with the general healthy appearance of the roots of gumming trees precludes the possibility of the fungi present having any influence. Although it is unlikely that any parasite is involved in gummosis, it was thought that inoculation experiments with the isolated bacterium might be of interest, even were symptoms other than those found in gummosis produced.

2. *Inoculation with Isolated Parasites.*

A few inoculation experiments were undertaken with the bacterium isolated from gummosed tissues, possibly identical with Greig Smith's *Bacterium acaciae*. In March and April, 1939, bacterial slime was introduced with a needle into the bark of six healthy trees. No gummosis has as yet resulted.

In order to investigate the possibility of a virus causing gummosis, grafting of pieces of gummosed bark on healthy trees was tried. The problem here was to make the piece of bark fit exactly into the space provided, and even then it was found difficult to close the wound from the air so as to prevent it from drifting out. The wounds were first covered with Elastoplast, but this would not adhere when the bark was wet. Then an asphaltum emulsion was tried in combination with Elastoplast so as to prevent direct contact of the wound with the asphaltum, which might kill the pathogen. This preparation gave better results than the Elastoplast alone, but the asphaltum naturally started to crack as soon as excessive moisture or growth caused the stem to swell. Consequently many of the plasters were thrown off before fusion between the corresponding tissues had been established. A third method, which is at present being used, promises better success. This consists of wrapping adhesive insulation tape round the trunk so as to cover the entire wound, and leaving it for at least a month. Owing to a slight elasticity in this dressing, it very seldom cracks, and covers the wound so satisfactorily that it does not dry out at all. Nor does it produce any wound gum. There are no results as yet reported.

Besides the experiments suggested by my own isolations, inoculations were performed, in view of Dr. Laughton's findings, with *Diplodia natalensis* (Stephens and Goldschmidt, p. 37). A pure culture of this fungus was obtained from the Centraalbureau voor Schimmelcultures, of Baarn, in Holland. The fungus was introduced under the bark of fourteen black and two green wattle trees, and the wounds covered as described above. In several instances, even where the plaster had come off, excellent growth was observed, although up to the present no symptoms of disease have appeared.

In all these inoculation experiments, it might be mentioned, corresponding checks were treated in exactly the same way except that no organism was introduced. So far the results of inoculation have been all negative. It cannot, however, be assumed that parasites have no bearing on gummosis until all the experiments described as well as later initiated ones have been carried to finality.

3. *Nutrient Requirements of Wattles.*

The seeds used in the experiments to be described were subjected to the usual boiling treatment to stimulate germination. Subsequent disinfection with a .1 per cent. sublimate solution appeared to help still further. Care was taken to let the seeds germinate in weak diffuse light, as direct sunlight has been found to inhibit germination as much as fifty per cent. Germination therefore took place mostly on moist blotting paper in Petri dishes placed in a dark corner of the laboratory.

For solution culture, seedlings two cm. high were first transferred to a wire strainer placed over a basin of water, and the whole covered

by glass or wet filter paper to keep the air moist. By this means the rootlets were enabled to grow straight downwards and furnish suitable material for transfer to their final medium. At this stage the seedlings were kept out of doors in strong diffused light to prevent etiolation. They were transferred to their respective solutions when about six to seven cm. long, just before the spreading of their first leaves. It was found that the seed-coats inhibit initial growth to so varying an extent that a most irregular set of plants results. The seed-coats were accordingly carefully removed as soon as the seedlings were taken from the Petri dishes.

Planting was done in screw-topped Mason jars, each containing 1900 ccm. of solution. The jars were treated with potassium bichromate and sulphuric acid before use. Holes were made in the lids so that either one or three plants might be fixed into them, supported and protected from the sharp edges by cotton wool. The lids were painted white outside and covered with paraffin inside. The jars were wrapped in brown paper to prevent algae from growing in the solutions.

For sand cultures ten 2 cm. seedlings were planted to a tin nine inches square and six deep, covered with a layer either of solid paraffin or tar. The sand was slightly moist at planting, about one litre of distilled water having been added to each tin. A further half litre was added immediately after planting.

Inoculation.

Both kinds of cultures were inoculated with nodule bacteria either [illegible]fter planting or from one to several weeks later: the sand cultures by pouring a few ccm. of a bacterial suspension in distilled water round the base of each seedling, and the solution cultures by applying the undiluted bacterial slime to the roots with a small brush.

Treatment of Cultures.

All cultures were kept out of doors in a wire cage, which in case of rain could be converted into a shed by pulling down a few blinds. When required, the sand cultures were watered with a dilute culture solution. The jars containing culture solution were filled up with distilled water whenever transpiration made it necessary. Renewal of solution did not appear necessary until after a few months, the precise period varying according to rate of growth and number of plants per jar.

Solution Used.

Solutions were made up with distilled water and the purest available chemicals (Merck's C.P.) used, so as to exclude traces of other elements.

The first aim in these experiments, before the subject of mineral deficiencies could be dealt with, was to find a solution that would promote healthy growth. Preliminary experiments were carried out in winter in a greenhouse, and though hampered by cold and an entire lack of direct sunlight, the results obtained were of some value in planning succeeding experiments.

First of all, different types of solution were selected in order to determine in which the wattle seedlings would thrive best. As standards, the following solutions used by different investigators for different kinds of plants were taken :—

McMurtry's solution (1933), used for tobacco.

Mes's solution (1930), used for tobacco.

Zinzadze's solution, quoted by Waringtón (1933).

One of the Rothamsted solutions, used for sugarbeets and *Leguminosae* (Rowe, Brechley, and Waringtón).

Bryan's modification of van der Crone's solution, used for soy-beans (1922).

Of these solutions, Mes's is richest in minor elements. It contains Al, Cu, I, F, and Zn, whereas the others are totally devoid of these. Bryan's and Zinzadze's lacked also Mn and B. Except for Bryan's, which contains no N at all, all solutions contain nitrates. Zindzadze's contains an ammonium compound as well.

The different solutions varied in concentration and in pH and N content. The last mentioned was varied because of its recorded influence on the nodule formation of certain *Leguminosae,* especially in solution cultures.

In spite of the care taken, very few nodules have so far developed in solution. The first to show were in a N-free solution after two and a half months. A little later a few others appeared in a complete culture solution containing a moderate quantity of nitrate. The seedlings on which they developed, however, did not benefit by association with the bacteria. They looked indeed no more vigorous than their neighbours. Apparently as stated in relevant literature, absence of sufficient sunlight is an inhibiting factor in the formation of root nodules. Even inoculating a jar with root nodules themselves did not induce any nodule development, nor did seedlings in soil containing numbers of wattle nodules develop any under the same conditions.

Preliminary observations were also made on the influence of the pH. A Rothamstead solution, pH 6.3, was modified so as to compare this pH with 3.9 and 7.8. The effect was that after one month, the 7.8 series looked far the best, although the roots were softer than normal and showed the brown discolouration typical of injury from high pH. This phenomenon has often been reported (Mes 1930), and was repeatedly observed in later experiments. The set of seedlings in the most acid medium showed another typical symptom, viz., very thick white roots (Mes.).

The most suitable of all these solutions appeared to be that of Mes, in which a few plants were kept for nine months, first in the above-mentioned unsuitable conditions, where they compared well with pot-plants of the same age in soil from a wattle plantation, and since September, in the open. Naturally they are still small in comparison with those of the same age in the field, but they look perfectly healthy. The ready response of these plants to the better light and temperature conditions of summer is shown by the growth of one seedling which at seven months old in November measured 25 cm. in height, and at nine months old in January, 50 cm. Several plants measured 20 cm. at three months. The seedlings thrived in double concentrations, in fact they seemed to do better in the strong concentrations than in normal solutions. They appeared to starve in the latter.

Neither the Zinzadze solution in its original form, nor as modified by exclusion in turn of N, NO_3, and NH_4, proved suitable. The roots

of the plants looked normal, but all plants shed their leaves within a month, and showed a kind of "silver leaf" phenomenon.

Guided by the results described above, experiments were planned for sand and solution cultures outdoors in spring. Mes's solution was taken as a basis, the proportions of the elements introduced being adjusted to Steyn's wattle leaf analysis (1938). Care was taken in selecting the quantities and dilutions of the solution so as to obviate injury to the roots by too high a concentration. The limit of safety in this respect was certainly not exceeded, as no sign of injury was noticed during the three months' course of the experiment. Our knowledge of the nutrient requirements of these plants is very limited, and the effect of higher concentrations on rate of growth should be investigated. The composition of the different stock solutions is reflected in Table I. For solution culture the solutions figuring there were diluted ten times, and for sand culture thirty times. When moisture was required in the sand cultures, the tins were watered with the weaker solution, each tin receiving in all 6,525 ccm. during the three months' duration of the experiment.

Each set of solution cultures consisted of six jars containing three seedlings each, and each set of sand cultures, of six tins of ten seedlings. Half of each set received the following quantities of trace elements per litre of distilled water :—

KI	.250 gr.	$CuSO_4$	.125 gr.
$ZnSO_4$	.500 ,,	$Al_2(SO_4)_3$	.500 ,,
H_3BO_3	.500 ,,	CaF_2	.250 ,,
$MnSO_4$	1.000 ,,		

TABLE I.

COMPOSITION OF STOCK SOLUTIONS.

Solution No.	GRAMS PER LITRE OF DISTILLED WATER.						
	KNO_3	KH_2PO_4	K_2HPO_4	$Ca(H_2PO)_2$	$CaSO_4$	$CaCO_3$	$Mg.SO_4$
1	22.5			5.0			2.5
2	5.0			15.0			10.0
3	5.0			7.5	7.5		10.0
4		5.0	5.0		10.0		10.0
5		5.0	5.0			7.5	12.5

Small quantities of a solution containing .5 grams of iron tartrate per litre were added whenever required.

Of the three tins receiving similar treatment, one was covered with paraffin and contained pure white sand, purchased from the Sand Supply Company, Pretoria. Another was covered with paraffin and contained builders' sand. The third was tarred and contained pure white sand. After six weeks it became evident that solution No. 2 was unfavourable.

Although every plant had been inoculated with a suspension of nodule bacteria about a week after the start of the experiment, and again three weeks later, the sets without nitrogen in solutions 4 and 5, seemed to starve. Growth was absolutely stunted and the few leaves

developed by the plants were yellow. While those in the builders' sand were markedly smaller than the others, their colour remained normal, probably by virtue of the N-reserves in the soil, or perhaps owing to their well developed root nodules. This point will be further discussed in connection with the eventual effectiveness of nodule bacteria. As no obvious advantage in paraffin as compared with tar could be detected, both coverings will be used in future experiments.

In the solution cultures, which were kept for two months only, solution No. 1 was found superior to No. 3. In the sand cultures, kept for three months, set 3 looked stronger than set 1. On the whole the plants of the builders' sand set looked far better than the pure sand set, although a few plants in set 3, with traces added, could compete with the best amongst them. Owing to differences amongst the plants of individual tins, comparison of average quality of the different sets presented some difficulty, but the differences mentioned were too obvious to doubt. Probably owing to the short period during which this experiment ran, and possibly owing to the lack of pure chemicals at the time—Merck's were not then available—no conclusion could be drawn about "trace" deficiency symptoms.

Certain abnormalities observed in roots in solution culture may be due to unfavourable pH. In set No. 2 (pH changed from 6.5 to 5.2) the roots were short, thick, white, and irregularly branched. In sets 4 and 5, they were soft and brownish. Other factors besides pH must be involved here, as the initial pH of set 1, which produced healthy, long, and regularly branching roots, was of about the same pH as set 4, i.e. 7.3.

Growth during summer was at least twice as rapid as in winter (in the greenhouse). Results of an experiment initiated in spring for the purpose of comparing the efficacy of certain solutions were therefore obtained much more rapidly than in previous attempts. The solutions compared were Hoagland's (1933, used for strawberry plants) with the trace elements contained in his solution "A"; Mes's; Mes's with the iron phosphate replaced by iron tartrate; and solution 1 of Table 1. After about two weeks solution 1 was found to take the lead. Mes's was nearly as good, but Hoagland's lagged far behind all the others. Results of experiments started in mid-summer with "Merck's chemically pure" material are not yet available.

4. *Root Nodule Bacteria.*

Investigations on root nodule bacteria consisted of isolation of the organism from nodules collected in different plantations, and inoculation of experimental plants with the isolated organism to determine whether any benefit results therefrom.

Isolation.

Isolation was carried out in accordance with the technique described by Fred, Baldwin, and McCoy (1932). Contaminations were eliminated by subjecting all strains of presumed *Rhizobium* to Fred, Whiting, and Hastings's (1926) purity tests with congo-red-mannitol agar, litmus-milk culture, and culture on potato slops. According to Fred, Baldwin, and McCoy's description of Rhizobium, "the well isolated colonies on the surface of the agar are raised, wet, shining, and somewhat translucent, with smooth edges." They also claim that the consistency of the colonies depends on the host species. Some are decidedly mucilaginous,

and the wattle root nodule bacteria seem indeed to belong to this group. Up to the present, five strains from different localities in Natal have been isolated, while a sixth was obtained from Nairobi through the kindness of Dr. H. S. Fisher, Research Officer to the Natal Tanning Extract Company, Pietermaritzburg. The only definite proof that the actual Rhizobium has been isolated is in the development of nodules after inoculation.

Inoculation.

The methods of inoculation employed were those described on page 34. Because of the mucilaginous consistency of the bacterial mass, it adhered very easily to roots in solutions when the slime was applied directly to them. The results in nodule formation, however, have been poor. After repeated inoculation in winter with two strains of nodule bacteria, only three plants developed a few nodules after two and a half months. The first plant to respond was one in Bryan's solution, which contains no nitrogen. This suggests nitrate deficiency in the solution as an inhibiting factor. See in this connection Marchal (1901), Fred, Whiting, and Hastings (1926), and Lohnis (1930). This probability is strengthened by the fact that the second and third plants to develop nodules developed on McMurtry's solution, containing .1 gram KNO_3 per litre, or only one tenth of the KNO_3 content of Mes's. As these plants looked yellowish and starving, the bacterial association was probably of no benefit to them, or at any rate inadequate for their nitrogenous requirements.

Three sets of plants were grown in Mes's culture solution, containing respectively 1.0, .5 and .1 gram KNO_3 per litre. Inoculation with two different strains of bacteria took place at planting and again four weeks later. After two months the first set, only, looked healthy, and no sign of nodule development could be observed on any of them.

No more attention was paid for the time being to the production of nodules in culture solution, as it seemed to be much more practicable to grow healthy seedlings with plenty of available nitrogen, but without nodules. The experiments were therefore continued with seedlings that were inoculated once only, either one week or one month after planting, and although conditions of light and temperature must have been more favourable in summer, no nodules have yet developed.

The sand culture nodule forming plants used in the nutrient experiments, it will be remembered, were all inoculated twice with a suspension of root nodule bacteria. Further experiments at that time, however, showed that nodules develop on seedlings planted in summer in builders' sand, even without artificial inoculation. It would seem that either bacteria were present in the sand, or disinfection of the seed had failed to kill any that might have been present on the seed-coat. As the seed had been collected from the ground, the presence of bacteria on their coats might naturally be expected.

In the nutrient experiments plant sets No. 4 and 5, in builders' sand without added nitrogen, nodules developed freely. In sets 2 and 3, to which moderate amounts of nitrogen had been added, considerably fewer nodules developed during the three months of the experiment. In set 1, with large additions of nitrogen, three plants, only, developed two or three. The effect of varying the nitrogen addition was disclosed

not only in the number of nodules developed, but in their distribution and shape. In sets 4 and 5 they arranged themselves in clusters, always near the main root, and were oblong and light coloured, especially towards the somewhat broader apical end. In the other sets, more particularly in set 1, they were dark brown and smaller and rounder, and were scattered over the roots.

Whether these nodules originated from the added strains or from one present on the seed or in the sand, or not, the manner of their occurrence confirms earlier findings regarding the influence of the nitrogen content of the substratum.

Although poor in themselves, the results from cultures in pure sand are in agreement with the preceding. Only three plants of these sets (20 tins), in set 5, produced nodules, and only a few on each. Their arrangement and shape corresponded with those of sets 4 and 5 in builders' sand. The outstanding fact regarding them was the superior development of their host plants. In one tin, the only seedling that was not actually starving, and that looked green, although it was far behind those in sets 1 and 3, was the only one to produce nodules. There is therefore no doubt regarding the beneficial influence of root nodules in sand without nitrogen. At the same time, the complete agreement between the results of the sand and solution experiments, convincingly indicates that wattle seedlings are more dependent on the nitrogen content of the substratum than on nodule bacteria in ensuring their nitrogen requirements.

5. *Vegetative Propagation.*

The foregoing experiments illustrate the desirability of securing uniform plant material for investigation. Comparability in susceptibility and rate of growth is of greatest importance in comparing results. In seedlings such comparability is low, but a much higher degree might be expected in vegetatively propagated material. Wattle growers, unfortunately, have never had occasion to resort to the method, and so I was unable to obtain any advice in the matter from foresters or farmers. In France it is reported (Baltet 1903) that Acacia may be propagated by "Marcottage," that is, bending low branches over into contact with the soil. Wattle branches are unsuited for this, and, moreover, as only very young mother trees would be required there would be difficulty in establishing their susceptibility. Another method recommended by Baltet is the taking of root cuttings during the resting season. This came to my notice only at the commencement of spring and I have not, therefore, been able to test it. It is doubtful, however, whether wattles have any resting season. Bailey (1920) writing on Acacia, remarks, "also increased by cuttings of the half-ripened wood."

In the absence of further information attempts were made to strike cuttings in different seasons. About a thousand were planted in August, September, November, December, and January. No success has as yet been achieved. The leafy cuttings were allowed to stand overnight with their cut ends in contact with distilled or tap water, or with solution of plant hormones of proved efficacy in promoting root growth. In some cases the bark at the cut ends was removed to increase the surface of living tissue. After standing for some 20 hours the

parts that had been immersed were rinsed and the leaves in the great majority of cases removed. In some a fresh cut surface was made, and all of them were then planted in wet sand or sawdust. Treated in this way they absorbed considerable quantities of the hormone solutions, especially when the sun shone during part of their immersion.

During the cooler season some of the cuttings, especially the thick ones, kept alive for more than two months, developed new leaves, and looked generally promising. Not a single root, however, developed, and eventually they dried out and died. The thin ones, without such food reserves as would enable them to produce new leaves, died much earlier. In the hot season, cuttings kept alive for a fortnight at most, and it was extremely difficult to prevent them from either moulding when covered, or drying out when open to the air.

Treatment with five different phytohormones in varying concentrations was tried with negative results. Naphthalene acetic acid, indolyl acetic acid, indolyl propionic acid, indolyl butyric acid, and "Hormone A" as prepared by the Imperial Chemical Industries, Ltd., were used, in concentrations ranging from 1 in 20,000 to 3 in 20,000. Failure to achieve results is not surprising, considering Tincker's failure with four Acacia species, including silver wattle (*Ac. dealbata*). It seems improbable that wattles can be successfully propagated by branch cuttings, and it is hoped that trials with root cuttings will prove more successful.

Albert Falls Disease

While it is agreed with Stephens and Goldschmidt (S. & G. P. 35) that gummosis is the most serious of wattle disease from an economic point of view, the incalculable menace of the Albert Falls disease must be apparent to any one who is confronted with its ravages. Current losses from gummosis may far exceed those caused by Albert Falls disease; but whereas a considerable percentage of trees recover from the former, and some, even on heavily infested areas, are not affected at all, the latter spreads rapidly from diseased centres, attacking every tree in its advance, and killing them outright. No cases of individual resistance to the disease has been observed. Once it appears in a plantation, there is no escape from it.

Despite its centrifugal advance, no signs of parasites, diseased roots, or distinct discolouration in the wood of the trunk, have yet been found. The presence of a dark fungus on wattle roots as reported by Dr. Laughton does not necessarily indicate a pathological condition. Dark mycelia have, indeed, been found during the present investigations indiscriminately on the roots of healthy and diseased trees in many different localities.

Attempts at isolation made by Dr. Laughton are described on P. 36 of Stephens and Goldschmidt's paper. The following observations were made by the writer.

From 22 chips taken from a withering black wattle, 19 remained sterile, two produced a *Phoma,* and one, a *Pestalotia.* From 34 chips taken from a dying green wattle showing a slight discolouration which could hardly be considered abnormal, 15 proved sterile, two developed bacteria, and the remaining 17, four different fungi, including a *Mucorinae,* a fungus forming pycnidia, and a *Trichoderma.* Of another sample from a dying tree with a slight but not distinctly abnormal

reddish discolouration in the wood of the trunk, 24 chips were tested. Of these, seven remained sterile and six developed a bacterium, in some cases associated with a fungus. From the remaining chip yet another fungus was isolated. These isolations being indeterminate, further observations and investigations will have to be undertaken.

Root Collar Rot

Root collar rot occurs regularly in most plantations, though seldom on so large and devastating a scale as gummosis and Albert Falls disease. Its most easily recognised symptom is the eventual wind throw of affected trees after advanced decay of the root collar. This, of course, happens at a very advanced stage of the disease, and the pathologist in search of the cause of the trouble must look for earlier symptoms. These may be described as a blackening, cracking, and gumming of the bark at the base of the tree, resulting in further decay of the root collar. Isolations attempted at all stages in the course of the investigation are summarised in Table II. Often a mycelial growth is observed on the surface or in cracks and fissures of the bark. In trees felled at this stage mycelia may be found between the bark and the wood (see sample 3 in Table II), or red or brown discolourations in the trunk wood (samples 1, 4, 8, and 10). In an apparently less advanced stage, the wood may look quite healthy, but the bark may have been invaded by fungal hyphae (samples 6 and 9). Withering (samples 4 and 5), or yellowing of the leaves (sample 9) are sometimes caused, or at least accompanied, by the disease. It has been found that the organism most frequently associated with these phenomena is a brown, sterile, mycelium-forming sclerotia, provisionally identified as *Rhizoctonia*. This organism is particularly prevalent in the earlier stages of the disease. With advancing stages a greater variety of organisms are isolated, and *Rhizoctonia* less frequently. In these later stages *Hymenomycetes* play an important part, apparently as weak parasites or saprophytes. It would seem therefore that *Rhizoctonia* may be the causal organism of root collar rot. According to Miss Lurie, the fungus isolated by her and identified as *Rhizoctonia,* as recorded by Stephens and Goldschmidt, p. 37, differs from mine.

In order to establish the pathenogenicity of my isolation, healthy wattle trees were inoculated with the *Rhizoctonia* mycelium in pure culture on prune, malt, and oatmeal agar, by insertion under the bark, either at the bottom of the trunk, or on a root, or both. Two lengthwise incisions were made, and sometimes a transverse one as well. The wounds were protected as described on p. 34. Thirty-three trees from three to six years old were thus treated in different seasons. No results are as yet available.

Conclusion

Results obtained in connection with the three diseases dealt with are so indeterminate that research on the lines described should be continued and other avenues explored. An important line of approach which has not yet been touched upon is the selection of gummosis resistant strains of wattle seedlings. Another is the analysis of affected and unaffected wattle soils with regard to their physical structure, their mineral composition, with special reference to the so-called "trace elements," and the micro-organisms in the soil. Time and lack of

TABLE II.

ISOLATIONS EFFECTED IN ROOT COLLAR ROT CASES INVESTIGATED.

Sample No.	Age of tree. Years	Number of undermentioned fungi isolated									Remarks
						Hymenomycete					
		Rhizoctonia	Penicillium	Trichoderma	Fusarium	Coprinus	Other species	Other	Sterile Pieces	Total Number of attempts	
1	—	—	—	—	—	—	2	—	8	10	Red discoloured wood of trunk of dead lying tree.
2	5	—	2	3	3	—	5	2	1	16	Dead standing tree.
3	5	6	—	1	—	—	—	—	—	7	Root of No. 2. Wood dying, bark alive.
4	2	—	4	3	—	—	2	8	—	17	Dead standing tree. Mycelium between bark and wood.
5	2	4	10	4	2	—	—	1	—	21	Red discoloured wood of withering tree.
6	2	2	1	—	—	4	—	1	3	11	Withering tree.
7	2	10	—	—	—	—	—	2	—	12	Isolated from healthy looking wood. Greenish discolouration of bark at collar. Mycelium in bark parenchyma.
8	5	12	—	—	—	—	—	—	—	12	Isolation from one dying side root. Root and trunk wood healthy.
9	—	7	—	6	—	—	—	—	—	13	Lying tree. Root rot. Red discolouration of wood.
10	—	5	—	—	—	—	—	—	1	6	Excessive yellowing of branches.
11	4	—	—	—	—	—	9	6	26	41	Withering windfall. Red discolouration in wood of trunk bottom and tap root.
Total	—	46	17	17	5	4	18	20	39	166	

facilities are the principal reasons why work on these problems has not yet been initiated, and it is hoped that these factors will not always limit the scope of investigations.

Summary

Gummosis.

Attempts at isolation disclosed no regularly or frequently present organism in diseased bark. Inoculation experiments were, however, carried out with one bacterium and a *Diplodia* formerly isolated by another investigator. No disease symptoms have yet appeared. Bark grafting experiments initiated to disclose any virus infection that might be present also yielded no positive results. By means of comparison and modification of different culture solutions suitable compositions were found for solution and sand cultures. These are now being used for examining the effect of mineral deficiencies on wattle. Different strains of nodule bacteria from different localities were isolated. Inoculation of wattle seedlings in sand and solution cultures resulted in very few nodules. The results obtained, however, indicate that nodules develop more readily in sand or solutions poor in nitrogen, where the seedlings seem to draw some benefit from them. The presence of nodules does not, however, compensate for total absence of nitrogen.

Albert Fall Disease.

Observations and isolation attempts failed to discover any parasite, although the manner in which the disease spreads points to a parasitic cause. The time elapsing between the first yellowing or withering symptoms and total withering of the tree may be only a few days. No earlier stages of the disease could be found.

Root Collar Rot.

From isolation attempts it appears that root collar rot is probably a parasitic disease due to a fungus identified provisionally as *Rhizoctonia.* Inoculation experiments with this fungus have been carried out in different seasons, as yet without results.

References

Bailey, L. M. : Nursery Manual. 1920.

Baltet, Ch. : La pépinière. 1903.

Brenchley and Warington : The Role of Boron in the Growth of Plants. *Ann. Bot.* 41, 1927, p. 167.

Bryan, O. C. : Effect of Different Reactions on the Growth and Nodule Formation of Soybeans. *Soil Science.* 13, 1922, p. 271.

Fawcett and Klotz : Types and Symptoms of *Psorosis* and *Psorosis*-like Diseases of Citrus. *Phytopathology.* 28, 1938, p. 670.

Fred, Baldwin, and McCoy : Root Nodule Bacteria and Leguminous Plants. Univ. Wisc. 1932.

Fred, Whiting, and Hastings : Root Nodule Bacteria of Leguminosae. *Univ. Wisc. Agr. Expt. St. Res. Bull.* 72, 1926.

Haas and Klotz : Further Evidence on the Necessity of Boron for Health in Citrus. *Bot. Gaz.* 92, 1931, p. 94.

Hoagland and Snyder : Nutrition of Strawberry Plants under Controlled Conditions. *Proc. Amer. Socy. Hort. Science.* 30, 1933, p. 288.

LÖHNIS, M. P.: Investigations on the Ineffectiveness of Root Nodules on Leguminosae. *Zbl. Bakt.* ii, 80, 1930, p. 342.

MARCHAL, E.: De l'Influence de la Nutrition Minérale sur le Développement des Nodosités des Légumineuses. *C.R. Ac. Sc., Paris,* 133, 1901, p. 1032.

MCMURTRY, J. E.: The Effect of Boron Deficiency on the Growth of Tobacco Plants in Aerated and Unaerated Solutions. *Journ. Agr. Res.* 38, 1929, p. 371.

MES, M. G.: Fisiologiese siektesimptome van tabak. Diss. Utrecht, 1930.

ROWE, E.: A Study of Heart-Rot of Young Sugar Beet Plants Grown in Culture Solutions. *Ann. Bot.* 50, 1936, p. 735.

SAVASTANO, G.: Una Gommosi del Limone Causata da Dothiorella. *Boll. R. Staz. Pat. Veg.* Firenze, 12, 1932.

SIRAG-EL-DIN, AHMED: Citrus Gummosis in Egypt. *Tech. & Sci. Serv. (Mycol. Sec.) Bull.* 131. Min. Agr., Egypt. 1934.

SMITH, R. GREIG: The Bacterial Origin of the Gums of the Arabin Group. *Proc. Linn. Socy. N.S. Wales.* 27, 1902.

STEPHENS, R. P. and GOLDSCHMIDT, W. B.: A Preliminary Report on some Aspects of Wattle Pathology. *Jnl. S.A. Fy. Assn.* No. 2, April, 1939.

STEYN, M. S.: Unpublished Report, 1938.

TINCKER, M. A. H.: Further Experiments with Growth Substances and the Rooting of Cuttings. *Journ. R. Hort. Soc.* 53, 1938, p. 210.

TOXOPEUS, H. J.: Nadere Gegevens over de Gomziekte in Djeroek Manis (*Citrus sinensis* Osb.) en haar Bestryding. *Med. Inst. Plz.* Wageningen. 80, 1932.

VAN DER BYL, P. A.: Een studie van een vleksiekte van die Zwarte Wattel. Unie van Zuid-Afrika, Dept. van Landbouw, Afd. Plantkunde. Wetenschappelik Pamflet No. 4. Pretoria 1914.

WARINGTON, K: The Influence of Length of Day on the Response of Plants to Boron. *Ann. Bot.* 47, 1933, p. 429.

THE UTILISATION OF SOUTH AFRICAN GROWN *EUCALYPTUS SALIGNA*

By M. H. SCOTT

(*Senior Forest Products Officer, Forest Products Institute, Division of Forestry*)

Introduction

THE saligna gum (*Eucalyptus saligna*) is a native of the semi-tropical regions of New South Wales and Southern Queensland, where it is known as Sydney blue gum. Its large-scale cultivation in South Africa is of comparatively recent date, the oldest trees in the country being not much more than forty years of age. Of the 5,500 acres devoted to it by the Forest Department, less than 1,100 acres exceed 20 years of age. The tree is a quick grower and in favourable localities a height growth of eight feet and diameter increment of one inch per annum may be expected. It thrives in almost all the moist mountain and sub-tropical areas of the Union, and produces exceptionally clean straight stems.

In recent years it has been planted extensively by private enterprise almost exclusively with the object of producing props and other mining timber on short rotation. Large areas, notably in Zululand and in the North Eastern Transvaal, have been put under saligna. Prices ruling for mining timber have made it possible for supplies to be drawn from as far afield as the Eastern and Western Cape Province, and have greatly stimulated its cultivation in areas nearer the source of demand. It has, however, recently been estimated that the acreage at present devoted to the growing of mine props will for some time to come produce more than the mines' annual requirements and a note of warning against over-production in this field of consumption may, accordingly, not be out of place here. Without any intention either of encouraging or discouraging production of saligna saw timber, the following notes on the quality of the more mature timber and the uses to which it can be and has been put, are presented in the hope that they may be helpful to growers and others concerned.

Botanical Identity

In a critical examination of herbarium material from trees planted in various parts of the Union, it has been found that most of the trees hitherto known as *Eucalyptus saligna* belong actually to the closely allied species *Eucalyptus grandis*. Owing, however, to the comparatively difficult task of separating these species in the field, and in view of their possible hybridization, it has been decided to retain the better known name of saligna in all cases except where scientific exactitude is called for, and accordingly for the purposes of this paper the specific name, saligna will denote either or both of these species. The notes that follow are based on examination at the Forest Products Institute, Pretoria West, of the timber of the two species deriving from twenty

widely separated localities in the Union, varying from five to forty-two years in age.

Felling and Sawing of Logs

So far as the quality of the seasoned wood or its subsequent behaviour is concerned, the time of felling of saligna is of little importance. Felling in winter or late summer has, however, an advantage, in that logs felled then are exposed to a minimum extent to attack by borer beetles. In summer rainfall regions, moreover, air-seasoning at that time of year proceeds more rapidly than at others. The splitting of logs which is so common a feature, not only of saligna, but of all gums grown in South Africa, has little to do with season of felling. Logs felled in August appear to split just as badly as those felled at any other time of year. Young trees from certain areas split more than older ones, while butt logs and stems with large branches tend to split less than those from higher up in the stem and than logs free of large knots. The heavier and darker wood also splits less than lighter logs. With very few exceptions, however, splitting is comparatively severe.

End splitting in gum logs is not due to drying out, but is caused by stresses inherent in the living tree, designed probably to brace the long slender stems against the wind. This is shown by the appearance of cracks on log ends immediately after cross-cutting. Splitting may commence even before the log has been completely sawn through. Leaving the bark on logs does not retard splitting from this cause, although it is of very definite help in preventing the small surface cracks and splitting that does subsequently accompany drying out.

To avoid undue waste from splitting, logs should be fed to the saw in as long lengths as practicable, in order to ensure a good length of sound timber between end splits. Splitting commences in one or more planes on both ends of the logs and runs up the log for varying distances usually from one to three feet. The planes in which the splitting occurs at the opposite ends of the log do not correspond and an endeavour to save waste by sawing with the plane of the split at one end will be frustrated at the opposite end. In very short logs splitting may actually overlap near the centre and render them useless for sawing into anything except the smallest of dimensions.

The loss due to splitting may be reduced to a minimum by rapid conversion after felling, by dealing with longest practicable lengths of log, and by the breaking down of the logs by means of a frame saw in preference to a single cut saw. If a circular or band saw is used, the ends both of the sawn board and of the remainder of the log, in response to the internal stresses, tend to spring outwards, with the result that successive cuts will not be parallel to the previously squared surface, and boards thus sawn will be thicker in the middle than at either end. Turning the log after each cut in order to counteract this tendency is not really practicable. The only practical means of overcoming it is to break down by frame saw and thus release the stresses simultaneously on both sides. This practice results in a very accurate cut.

Even under the best conditions wastage in gum timber due to splitting amounts to from seven to twelve per cent. of the sawn boards.

Boards cut from near the centre of a log may continue splitting as they are being removed from the breakdown saw, and even divide completely in two. The movement may be gradual or abrupt. Abrupt splits, when the whole length of the board is affected, have been known to injure labourers working in close proximity.

Various methods to prevent splitting, have been tried. Binding the ends of logs with stout hoop iron, while preventing splitting in the log, does not relieve the stresses, and after sawing, boards treated in this way exhibit the same defects as those sawn from unbound logs. Strapping the ends of boards immediately they emerge from the frame saw has been found to prevent excessive casting and splitting in the heavier dimensions, but is not of much use in the more common thicknesses of half and one inch.

On account of the stresses in green boards it is advisable to edge or cut to width only after the boards have been seasoned. Attempts made to edge green boards to width have resulted in heavy wastage through casting.

SEASONING

The seasoning of saligna does not present any special difficulties. Stacked in the usual way, one inch boards will dry out to twelve per cent. moisture content under cover of a well ventilated shed in high veld conditions in 90 days. The minimum time recorded was 60 days for an exceptionally light consignment from Zululand which was dried under optimum conditions.

Unless a very much longer period for air-seasoning is allowed it is certainly advisable especially for any high grade work such as panelling or joinery to complete the seasoning in a kiln in order to remove stresses set up in air drying and to even up the moisture content. This final process takes only two or three days and is well worth the extra trouble. Boards 2¼in. thick air-dry to 12 per cent. in an average of 240 days, while 4½in. thick boards dry to only 21 per cent. after 400 days and would take at least two years to become air dry. Final conditioning in a kiln is most desirable in these cases. Kiln seasoning green from the saw has been very successfully accomplished in 21 days and all the indications are that this time could be considerably reduced.

In order to get the maximum use from a limited kiln capacity it is usual to make use of the rapid rate of drying which occurs in the early stages of air seasoning, and from the work carried out at Pretoria West, it would appear that a month to six weeks of air drying followed by five days to a week in the kiln would be the most suitable combination for 1⅛in. material.

The green moisture content of logs when felled may be as high as 150 per cent. of the dry weight of the wood but is usually between 110 and 120 per cent. In reducing this to 10 per cent. moisture content, which is the equilibrium for average conditions in the Union, a shrinkage across the grain ranging from 5 per cent. to 11 per cent. or from 5/16in. to 11/16in. on a 6in. wide board, occurs. The heavier wood has the greater shrinkage in nearly all cases.

Unlike many of the other eucalypts, which are apt to collapse, honeycomb, corrugate or surface check, saligna with extremely rare exceptions seasons with no further defects than the original splitting



Eucalyplus saligna logs from Woodbush. Size up to 11½" diameter, age 19 years. Split very badly after two weeks during transport in open before sawing.

already mentioned. In abnormally heavy material such as received from Elgin, Cape Province, surface checking has been observed, but irregular shrinkage and defects such as kino pockets are rare.

The worst defect in all the material dealt with is a natural defect. Dead knots were found to account for more wastage of otherwise perfect material than any other blemish. This was particularly the case in very fast grown material from Zululand and the Transvaal but was also severe in material from other sources such as the Western Cape Province and the Transkei.

The inclusion of snags and dead branches in the growing stem is largely preventable up to certain lengths. If more attention were given to cleaning the results would amply justify the operation.

Yields of Merchantable Timber

The question of yield of finished or partly finished material from round logs is one of vital importance and on this account great care must be exercised in the application of data obtained. The methods of measurement, the sizes of the sawn boards or finished product and the final grades accepted make a considerable difference to the yields. From experience gained over ten years the following figures can be taken as applicable to good average quality saligna logs of 14in. average diameter.

From 100 cu. ft. of round logs a yield of 55 cu. ft. of square sawn 1⅛in. green boards may be expected after allowing for defects such as knots and splitting, and the usual waste represented by slabs and sawdust. An allowance of 15 per cent. must be made for shrinkage in volume reducing the yield to 47 per cent. of the round, and a further 13 per cent. for seasoning and additional defects not noticed in the green board. The final yield of merchantable timber in random sizes would therefore be about 41 per cent. of the volume of the round log. If however boards are to be cut to a few stock sizes the yield would be reduced to from about 30 to 35 per cent. If the conversion is to be carried further and the seasoned boards cut and planed to a constant dimension as, say, for flooring, a yield of 18 to 20 per cent. based on the exact finished size of the flooring would be normal. This means to say that if timber is landed at the mill at a shilling per cu. ft. in the round it will cost five shillings per cu. ft. plus the cost of sawing, seasoning and handling, in the finished condition.

Figure Grain and Working

One of the great advantages of using wood for furniture, panelling, flooring, etc. is to be found in the variety of figure presented by the various pieces. Seldom are two pieces exactly alike, and *E. saligna* is no exception. Its appearance varies from the almost featureless timber of the young trees or from the centre of older trees to the beautifully marked wood usually obtained by cutting through the profiles of the growth layers as occurs in plain sawing larger stems. Radially sawn boards often present a mahogany-like ribbon figure, and an attractive wavy figure is sometimes met with. The grain is usually very straight and the texture fairly even though somewhat open. Most of the figure is derived from differences in colour and density between the zones of the growth rings.

The colour of the wood though generally pink to reddish, when first cut, may vary from straw colour to dark reddish brown and generally darkens on exposure to a warm reddish brown especially if treated with linseed oil. If it is desired to maintain as far as possible the natural colour a superior clear varnish with a pummice stone wax finish will give the desired result.

In working it has been found, as might be expected from the ranges in weight, that there is considerable variation. Experienced cabinet makers have given their findings to the effect that the wood works freely, and material slightly above the average weight is preferred for the best finish. On the other hand instructors have accepted saligna of average and slightly below average weight as most suitable for manual training schools.

The wood saws freely and clearly and planes up without difficulty to a good smooth surface which can be readily finished by sandpapering or scraping. It takes stain and polish well and can be made to resemble mahogany very closely, and in fact is often mistaken for that timber. It bores and mortises easily and makes a good glue joint.

Weight

Table I reflects the weights recorded for air dry (10 per cent. moisture content) wood of *E. saligna* from a number of different centres throughout the Union.

TABLE I.

Air Dry Weights of Saligna Timber from Various Sources.

Locality		Age	Average Diameter	Weight lb. per c.f. Air Dry (10% Moisture content)			Remarks	Identification No.
Plantation	Province	Years	Inches	Average	Max.	Min.		
Port Durnford	Z.	12	12	32	41	27		261
Klein Australie	N.T.	20	18	33	35	30		730
Woodbush Forest Plot	N.T.	31	17	36	39	30		717
Entabeni	N.T.	20	22	37	49	33		729
Barberton	E.T.	10	—	38	42	33		B
Kologha	E.C.P.	30	17	38	50	33		391
Tokai B32	C.P.	42	21	39	42	36		541
Tokai	C.P.	30	16	40	50	30		28
Baziya	T.K.	34	16	40	51	33		674
Nqadu 40b	T.K.	32	15	41	51	30		673
Rooikoppies	N.T.	12	16	42	50	36		50
Empangeni	Z.	25	15	44	50	36		266
Hanglip	N.T.	22	—	46	56	36		722
Woodbush A7a	N.T.	25	16	46	50	40		755
Elgin A9c	C.P.	36	16	51	60	30		813
Westfalia	N.T.	34	22	52	56	45		773
Rooikoppies	N.T.	23	28	53	57	46	Two trees only	R
Elgin A9c	C.P.	33	17	54	57	51	Three trees only	519

Z. Zululand. T.K. Transkei. N.T. Northern Transvaal. E.C.P. Eastern Cape Province. C.P. Cape Province.

These figures demonstrate the considerable variations which exist. Each tree as it increases in size produces successively heavier wood and there may be as much as twelve pounds difference per cubic foot between the inner and outer wood of any particular tree. After a certain age however, usually about ten or twelve years, the rate of increase declines.

In addition to this however there is the more important variation between trees of the same age and size from the same locality. Examples of this are the twelve year old trees from Rooikoppies in which the difference between the average weight of the heavier and lightest trees was 14lb. per cu. ft. Another example from Kologha gave a difference of 16lb. per cu. ft. as between trees. This difference has been noticed in nearly all consignments received and would appear to be due to inherent properties of the seed.

In determining the average dry weight of any consignment, wedge shaped pieces cut from end sections of a number of representative logs were taken thus maintaining the natural proportion of inner and outerwood. For direct comparison the wedges were taken at a constant height of about 13 feet from the ground.

Notwithstanding the variations shown in Table I a vast majority of the logs received fall into the weight class of 36 to 44 lb. per cu. ft. which is light for gum timber. The weight of freshly felled logs is approximately 65lb. per cu. ft.

Strength

It follows from what has been said above that considerable differences in strength may be expected. The inner core of the tree is invariably brash and lacking in strength while the long straight grained wood usually found towards the outside of the stems has good strength for its weight. The figures given below represent average stems and are given for comparison with better known woods.

TABLE II.

Comparative Strength Values of Saligna and Other Timbers.

Speciies	Origin	Age	No. of tests	Values					
				Moisture Content %	Modulus of Rupture lb./□ in.	Modulus of Elasticity 1,000lb/□ in.	End Crushing Strength lb. per □ in.	Hardness lb. End	Hardness lb. Side
E. saligna	Rooikoppies	10-12	7	9.0	12390	2377	8670	1040	895
E. saligna	Tokai	40	49	10.3	11677	1898	7605	1506	1130
Douglas Fir (Strongest Type)	U.S.A.	+100	Numerous	12.0	11700	1920	7420	760	670
Deal (Scots Pine)	Europe	+100	12	12.0	8930	1483	5990	748	562

Durability and Treatment

Saligna is not a durable wood. That is it deteriorates rapidly when exposed to conditions favourable to decay. As an untreated fence post or for other work in contact with the ground it has a life of two to three years under average conditions. It responds readily in the round to preservative treatment however, the sapwood absorbing sufficient preservative to protect the non-durable heartwood which as in the case of eucalypts generally cannot be impregnated with recognised preservatives. Creosote treated fence posts should have a life of twenty years and upwards under the most adverse conditions.

Many of the gold mines have considerably increased the life of their props by preservative treatment in metallic salts solutions while creosoted telephone and electric transmission poles will give a life of at least twenty years.

It should however be emphasised that if logs or poles are sawn exposing the heartwood longitudinally no treatment will give more than a very short additional life.

Apart from decay, saligna may be considered a fairly durable wood for use as benches, chairs, etc. Attack by powder post beetle is recorded only in respect of the sapwood of rough sawn boards which have been in storage for long periods. Treatment in Zinc chloride solution will render the sapwood immune. There is no record of any furniture or other finished product having been attacked in service during the 15 years over which observations have been made.

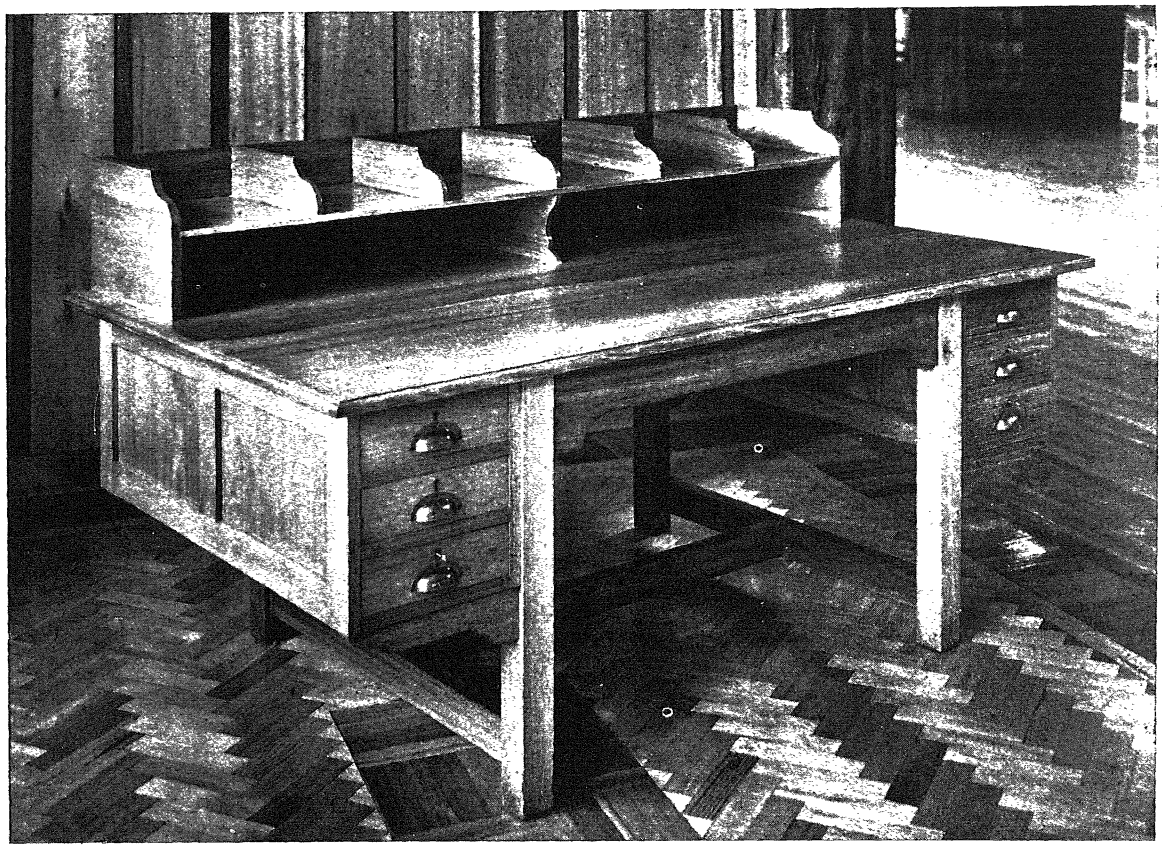
Uses

By far the greatest market for saligna is at present as a prop. The gold mines prefer this wood on account of its comparative lightness and good form. Its strength is sufficient.

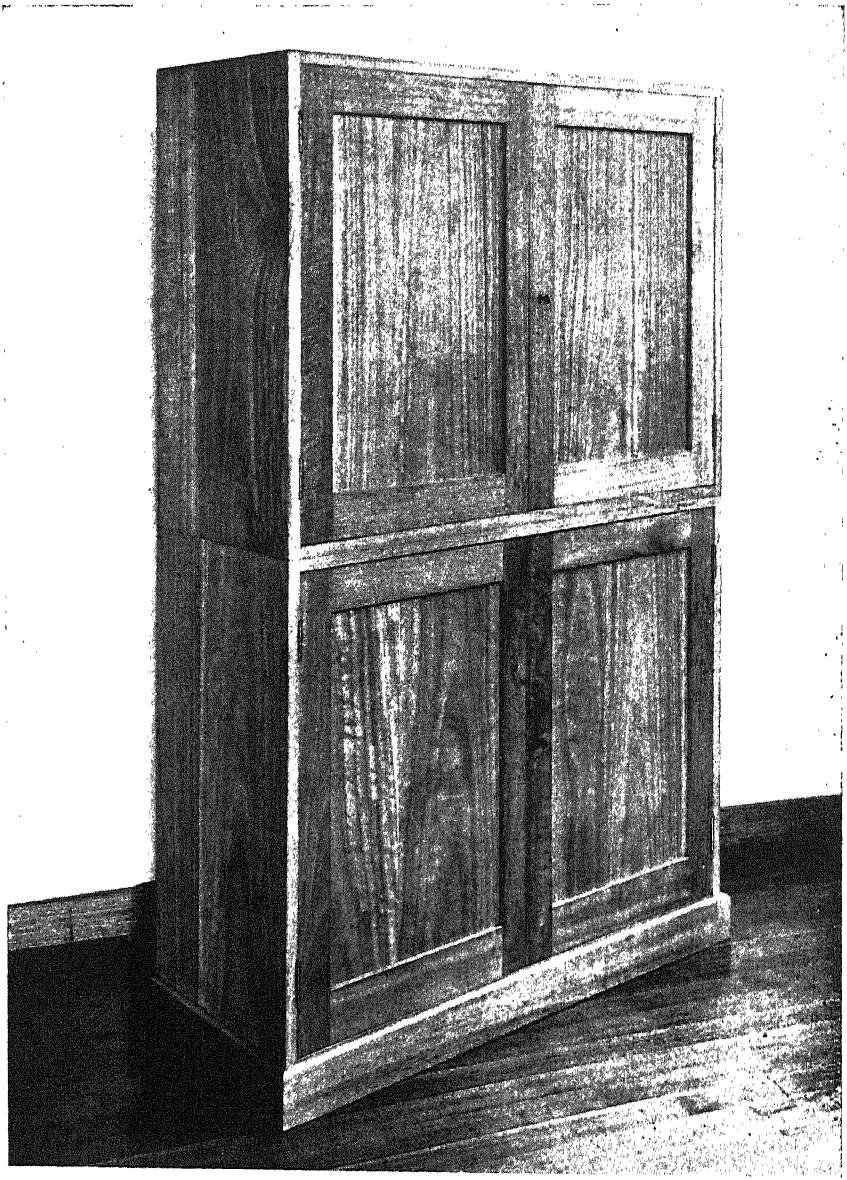
The use of chemically treated poles from thinnings for fence posts, telephone poles and electric transmission poles has already been mentioned. To this list might be added treated building poles, droppers, laths and round sleepers for cane track lines.

Young trees and in some cases trees as old as 20 years and more are being used for fruit boxes. The wood is usually easily distinguishable by its pinkish colour and is probably the only eucalypt used for this purpose. The shooks are cut green and if not immediately made up into the box are bundled straight from the saw and allowed to dry out in the bundle. A slight superficial blue-black discolouration may be present, due to the interaction of the iron from the saw and the tannin in the wood, but this is of little importance. The finished box though not up to the standard of the imported softwood box can with good sawing be made to look attractive, and this type of box is likely to be seen to an increasing extent in the next few years on account of the difficulty of obtaining the more suitable coniferous timber due to war conditions. Its main disadvantage is additional weight and a greater tendency to split in nailing. On the other hand it has the advantage of strength.

So far as the utilisation of wood from older trees is concerned it has been realised for some time that owing to the absurdly low price at which many imported hardwoods have been landed in the country, there might be some difficulty in disposing of this type of wood which



Office desk made of *Eucalyptus saligna* timber.



Cupboard made of *Eucalyptus saligna* timber.

is comparatively unknown except for rough usages. Attempts have therefore been made not only to indicate that the wood of saligna when properly seasoned can be used to advantage for a great many purposes, but actually to demonstrate this fact on a sufficiently large scale to be absolutely convincing.

As a start the Forest Department has furnished its own offices with desks, chairs, tables, cupboards and fittings of well seasoned wood of this species. These articles, many of which have been in use for ten or twelve years and are all standing well have been greatly admired. Their serviceability and attractive appearance have led to the use of the wood for panelling and framing. The Publicity Offices in the Johannesburg Railway Station are panelled with stained and polished saligna. Several other large scale examples of panelling are to be seen in buildings in Pretoria and elsewhere. In 1935 two thousand chairs of saligna were manufactured for use in Pretoria's New City Hall and in 1936 the Department of Public Works included this wood in its list of furniture contracts.

The use of saligna as hardwood flooring was one of the first experiments to be carried out. A floor laid in 1926 in Mr. N. B. Eckbo's residence in Pretoria is still in perfectly good condition. It has been noted however that some of the strips which were much softer than others dented easily, and this type of wood should be graded out. This would not be uneconomic as the softer material could be used for furniture backing, partitioning, or ceiling. The harder and heavier wood would make an admirable floor.

More recently a new church in Bloemfontein had some eighty pews made of saligna using a total of about 800 cu. ft., while the New Women's Hostel at Stellenbosch University is being furnished with this wood.

The Post Office is using wooden cross arms extensively and many of these have been supplied in saligna with a creosote treatment to give some addition protection from the weather.

Bearing in mind the possible overproduction of young trees suitable for mining timber other uses for this small material have been investigated from time to time. Probably the most important of these is its use as a pulp wood. As long ago as 1920 small samples of young wood were tested out at the Imperial Institute and later by the Union Department of Forestry. Some time after, promising results were obtained in America with Brazilian grown saligna. A pulping company was actually formed but owing apparently to some political upheavel the project was shelved. Further tests were carried out at the Imperial Institute in 1929, full details of which were published in a Report of the Imperial Institute Vol. XXVII No. 4 of 1929 page 449.

The results of all these experiments have demonstrated that *E. saligna* produces a good yield of comparatively short fibred pulp of only moderate strength. All the indications are that a longer fibred pulp would have to be added to give sufficient strength for use on a modern high speed paper-making machine. The short fibred pulp would be suitable for high grades of pulp where strength is not of major importance, but it would be quite unsuitable for kraft paper.

The next step would seem to be for experimental work on a large scale under expert supervision of specially trained men to confirm the results so far obtained. In this connection it should be born in

mind that paper-making is a very highly specialised industry needing careful investigation both on the technical and economic side and one which requires a capital of many hundreds of thousands of pounds. The disadvantages as they are known now would be an insufficient market in this country for the grades of pulp which can be made from saligna, and competition with large and highly organised concerns exporting paper to this country. The amount of wood absorbed by a paper mill would not exceed 100 tons a day so that even this would not go a long way to solve the problem of excessive production.

Conclusion

It has been shown that saligna when properly handled is a wood of some merit and one which can be utilised to a large extent in most stages of its growth. There may be difficulty however in the near future in finding markets for all the smaller material recently planted for mining purposes. This will especially be the case where the plantations are long distances from the source of demand.

The question as to whether the public should be encouraged to plant with a view to supplying sawtimber on a 25 to 35 year rotation immediately suggests itself. Although from a casual study of the imports of hardwood there seems room for optimism, the economic aspect of local timber grown in plantation form at some expense having to compete with imported timber mostly from old natural forests and highly selected for quality and size must be fully considered, and the grower cannot therefore expect a very greatly increased value per cubic foot for his larger trees.

Saligna should not be regarded as a substitute for softwood timbers except in special cases, and it could not hope to compete with timbers such as deal for building purposes. Individual growers are already experiencing difficulty in disposing of what timber is now reaching maturity except at very cheap rates, as there are few if any mills able and willing to deal with round logs for any but the roughest classes of work. The question of proper conversion methods and seasoning is of vital importance and has not generally been studied.

Large central mills correctly placed with modern equipment and seasoning facilities would seem to be a partial answer to the problem, and the only method likely to succeed. With such mills properly organised it is probable that the question of competition from imported material would not assume such importance and saligna might then become established on the market alongside such timbers as oak and teak.

MINING TIMBER IN SOUTH AFRICA WITH SPECIAL REFERENCE TO WATTLE SILVICULTURE

By R. P. STEPHENS

(*Forest Research Officer, Pietermaritzburg.*)

FEW primary producers have received greater direct benefits from the increased activity of gold mining than those growing mining timber. These producers fall into two classes—those who produce mainly gum timber and those who grow mainly wattle. It is with the latter class that this article is most concerned.

Until January, 1933, when the Union of South Africa left the gold standard, mining timber in the wattle industry was considered to be a by-product. There was little demand that silvicultural technique should be devised so as to conform with the production of wood sizes most acceptable to the mines.

During the past six or seven years, however, the position has changed completely. To-day the wattle grower finds that his mining timber constitutes from 25 to 50 per cent. of his net receipts (bark plus timber less cost of harvesting, handling and transport). Growers are therefore reluctant to apply any silvicultural system which will seriously affect their mining timber sales. The silvicultural recommendations of the Division of Forestry are designed on a long-term basis to reduce the cost of producing a unit of tan and to improve bark quality. Wattle growers are now widely discussing, and sometimes practising, modifications of these recommendations because of the effect which the latter will have upon timber sizes. An analysis of the current position is therefore due.

Consumer of Mining Timber

As shown in Table I the gold mines are by far the most significant consumers of mining timber.

TABLE I.

Value of Timber Consumed by Mines in South Africa.

Year.	Value in Pounds.				
	Gold.	Coal.	Diamond.	Other mines.	Total.
1910-37	31,240,000	1,500,000	1,200,000	750,000	34,700,000
1938	2,801,000	79,000	17,000	40,000	2,956,000

The figure for 1938 for the banket reef mines of the Witwatersrand System alone was only about £50,000 less than the figure given for all gold mines in the second column. The former are located in a relatively small half-moon shaped area some 200 miles long by 10 to 30 miles broad. The depth of mining varies from shallow to about 8,000 ft. below the surface.

Since January, 1933, gold mining activity in this area has greatly increased. It is interesting to record, however, that evidence for this increased activity is found not in any increase in the gold produced, but in the tremendously increased consumption of labour and stores. The data in Table II illustrate this point.

TABLE II.

GOLD PRODUCED AND LABOUR AND STORES CONSUMED.

Item.	Amount.	
	1933.	1938.
Gold produced	11,013,712 oz.	12,161,392 oz.
Stores consumed	£19,700,000	£31,200,000
Labour consumed	£19,900,000	£31,100,000

Of the amount spent on stores, the total expenditure for timber is about 9 per cent. and is exceeded only by the cost of explosives (including fuses and torches) and electricity. The expenditure on support timbers alone (with which the wattle industry is most concerned) in 1933, was about 5 per cent. of the total stores expenditure and worked out at about 6d. per ton of ore mined. From reliable estimates it would appear that this figure was approximately one third to one-fifth of the total cost to the mines for support work, including material and labour. The grand total of all costs (except direct taxation) is calculated to be about 20s. per ton of ore for mining and "reduction" operations.

TIMBER SPECIES USED

The data in respect of timber consumption given in Table I cover all classes of timber used by the mines.

Table III indicates the relative importance of the five classes into which this timber may be divided :—

TABLE III.

EXPENDITURE BY TRANSVAAL GOLD MINES ON VARIOUS CLASSES OF TIMBER DURING 1938.

Imported.			Local, including Rhodesian.	
Deals.	Oregon and pitch pine.	Other woods.	Poles, laggings, mat packs, etc.	Other woods.
£236,000	£620,000	£180,000	£1,550,000	£215,000

Imported softwoods mainly comprise timbers for shaft sets. It will be many years before the Union will be in a position to supply the large sized pitch pine (*Pinus palustris*) required for this purpose, but locally produced deals will doubtless become available in due course. The prices paid for the former are high compared with those paid for locally

produced timbers and the relative volumes used are therefore even smaller than those indicated by the figures of value. The third and fifth columns in Table III include such items as building timbers, clear pine, sleepers, wedges, headboards, hardwood planks and fuel. The fourth column is the one with which we are most concerned for it refers to "support" timbers.

Mine props in the early days of mining were obtained entirely from the felling of indigenous trees. For the last 25 or 30 years, fortunately for the country's indigenous forests, the bulk of these timbers have been obtained from locally grown plantations of Australian species of the genera *Eucalyptus* and *Acacia*. Black wattle (*A. mollissima* Willd.) and the following species of gums are the principal timbers used :—

Eucalyptus saligna, E. paniculata, E. maculata, E. Maideni, E. viminalis, E. camaldulensis (syn. *E. rostrata*), *E. tereticornis, E. sideroxylon, E. globulus, E. diversicolor* and *E. cladocalyx*.

There are numerous additional species which are also used, of which *E. Macarthuri, E. Dalrymple* and, *E. radiata, E. Lindleyana* (syn. *E. numerosa*) and *E. fastigata* will doubtless become of increasing importance.

Suitability of the Several Species for Support Purposes

There has in the past been remarkably little discrimination on the part of the mines regarding the species demanded. There is a demand for specially strong or durable timbers such as *paniculata* or *globulus*, but it is very limited.

The species used have been determined principally by availability. The result is that *E. saligna*, which is the easiest and cheapest gum to grow and transport, and especially *A. mollissima*, are the species used most.

The relative merits of these two species have been much discussed. Many mines favour wattle in view of its superior strength, particularly for "pig sties," and its greater durability, though on the whole consumers have shown fairly complete indifference regarding the species supplied. There are indications that this may not always be the case, and recently greater interest has been shown regarding the percentages of the two kinds to be supplied in future. The reasons for this change of attitude are not clear.

For certain purposes, however, wattle is definitely not as popular as *saligna*. This can be said to apply to most timber used in an upright position. For such uprights or "sticks" (timber 8 or 10 inches in diameter) straightness and freedom from knots are important requirements. Wattle does not generally come up to these specifications. In addition it is alleged that wattle "sticks" often snap without giving any warning, whereas *saligna* first "mushrooms" at the top thereby indicating the rate at which the hanging is descending.

The difference in durability between wattle and *saligna* will tend to disappear because of the policy which is being increasingly adopted, of treating all underground timber. The reason for this policy is an attempt to reduce the fire hazard (rotting timber is considerably more inflammable than sound timber) in old workings rather than to increase the "strength" life of the timber from a support point of view. The total cost of the recommended treatment, according to Mr. Bowen, Research Officer in charge of the Chamber of Mines Research Laboratory, is rarely more than 1d. per cubic foot.

Though differences in strength may cause preference for wattle wood, particularly for certain purposes such as solid packs or the framework of "pig-sties," it is not likely that there will be any marked change in the demand for *saligna*. Where *saligna* timber, in the form of packs, is considered unsuitable, the alternative will always be another form of support, as, for example, in the use of waste rock in place of a stronger timber. Support technique is not so exact a science that the differences between the strengths of *saligna* and wattle are likely to be significant.

Support Technique

General.

There are a variety of methods of supporting the hanging in stopes. Support technique varies according to mining conditions, depth and width of stope, the angle of dip, liability to pressure bursts, the individual technique of mine managers, the system of mining and according to the availability of waste in the form of steel cables or iron rails. The following are the commoner methods of support used :—

(A) Those requiring a minimum amount of timber : Pillars, ore and/or waste from stopes, stone walls, masonry and brickwork, waste packed in wire netting or steel cables, and telescopic concrete cylinders plus sand.

(B) Those using considerable quantities of timber : concrete discs capped with timber, pig-sties (cribs made of laggings filled with waste), spaced mats filled with waste, and sand filling with paddocks of laggings.

(C) Timber only : solid packs and uprights.

It is seen therefore that many methods use very little or no timber and presumably if no cheap timber was available, these methods would have to be adopted. For many conditions, however, they appear to be regarded as too rigid and timber is preferred. The possibility that concrete may entirely replace timber is not taken seriously by those with whom this subject has been discussed. While concrete pancakes are often unpopular amongst underground officials, there are, however, a number of high officials who do favour their use. They are fairly heavy to handle (30 inches in diameter and 3 to 4 inches thick), many get broken in transit, and sand, which is often not easily available, is usually used as a cushion between the pancakes. Being absolutely rigid they have the disadvantage that they crumble without warning. They are, moreover, invariably used with a substantial capping of timber. The fact that they are used to such a small extent is ample proof of their limitation, for the mines do not use timber for altruistic motives. There seems no doubt, that the mines could, if forced to do so, use considerably less timber than they do and should the price ever rise, there is little question but that the amount of timber consumed per ton of ore mined will drop. At present prices, however, timber appears to be the cheapest form of suitable support.

Timbering Technique

In the early days of relatively shallow mining, the supporting of the hanging was not nearly the problem it is to-day. The timber used was of large diameters (1 to 3 feet in diameter) and was always used

in a vertical position. With deeper mining, these large sticks were difficult to handle and had other disadvantages such as sudden breaking under great strain. These large timbers gradually gave way to the "pig-sty," which is a framework or crib made of round timber and filled with waste rock. According to conditions, these structures which are square (8 ft. x 8 ft.), triangular or in the form of a cross are spaced 6 ft. x 6 ft., 10 ft. x 10 ft. or 12 ft. x 12ft. throughout the stopes. The timber used is required to be fairly stout to give a strong frame and to-day many "pig-sties" are made with roughly-squared material derived from poles 5 to 8 inches in diameter.

"Pig-sties" are most commonly used in wide stopes (stopes about 6 feet and wider), where the dip of the strata is not very steep. A very large proportion of the stoping widths to-day are between 2½ and 6 feet. Under such conditions not only is there less waste rock, but sorting waste from ore is more difficult. For these narrower stopes, various types of the so-called "mat packs" or "chocks" are used. This type of support is said to have been introduced about 1926. The first "mats" used were of round material. The use of these "mats" was at first, apparently, an attempt by certain mines to accommodate the large amount of small diameter material on the market. They were immediately successful and are to-day extensively used in narrow stopes, and in many other places where space is limited. The pole sizes used are 3 to 5 inches in diameter in lengths of 2 to 4 feet.

The slabbed or roughly squared "mat" is said to have been an introduction from mining practice in other countries. If not, it would almost certainly have been the natural development of the round pack. Mats made of material of small diameter (3 to 4½ inches) are light and therefore easy to handle. In order to meet the demand for these sizes slabbing of larger sizes is often necessary. In any case, for certain conditions more solid packs are required than those given by round material and for this purpose it is necessary roughly to square round poles or slab them in such a way as to give a substantial width of flat face. This material is used in lengths of 2 to 4 feet to give a "rise" between the flat faces (which must be 3 inches at least in width) of 3 inches to 5½ inches. The longer lengths are used in the wider stopes, though 4 foot packs are often made up of 2 foot packs placed end to end.

There are a large number of different kinds of "packs" on the market and the rough sketches in Fig. 1 indicate the extent of the range. Some of these are the result of actual demands from the mines and others are attempts by distributors to dispose of large accumulations of waste wood.

Summary of Uses to Which "Support" Timbers Are Put

These include all the poles, lagging, "chocks" and "mat packs" used underground (see Fig. II). They may be regarded as falling into the following classes:—

(a) Stope supports. This is by far the largest item in mining timber consumption. It includes:—
  (i) "mats" made of round, squared or slabbed material, used solid, spaced with or without waste rock, and
  (ii) "pig-sties" or "cribs" made of laggings or roughly squared poles.

(b) Tunnel supports. These comprise poles 8 to 10 inches in diameter and laggings 3½ to 5 inches in diameter.

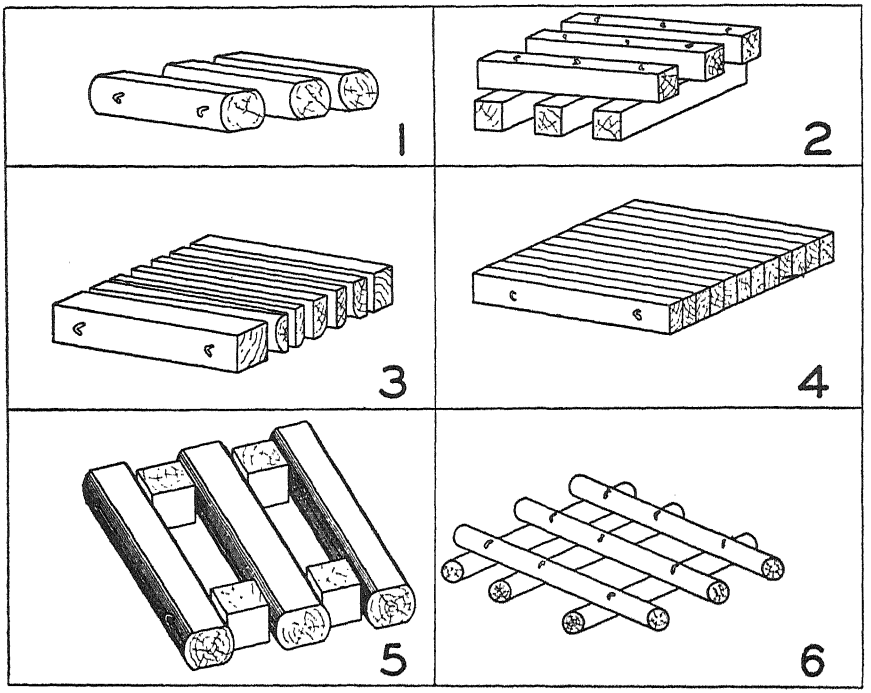
(c) Other material.

(i) wedges used in stopes and tunnels,

(ii) headboards used on "sticks" in tunnels,

(iii) sprags 3½ to 5 inches used in stopes to facilitate movement near working faces,

(iv) barricades of 2 to 7 inch material used in stopes to catch rolling fragments of rock. These include the so-called "gate-stulls" of 2 to 4 inch material used near working faces.



1. RISE I.E. DISTANCE BETWEEN SLABBED FACES VARIES FROM 3 TO 5 INCHES.
2. SIDED SQUARE VARIES FROM 3" TO 4".
3. IRREGULAR PIECES MADE FROM WASTE SLABS. RISE VARIES FROM 3 TO 4 INCHES.
4. USUAL RISE 3 INCHES.
5. RISE VARIES FROM 3 TO 4 INCHES.
6. DIAMETER VARIES FROM 2 TO 3·5 INCHES.

FIG. 1.—Various types of mat packs.

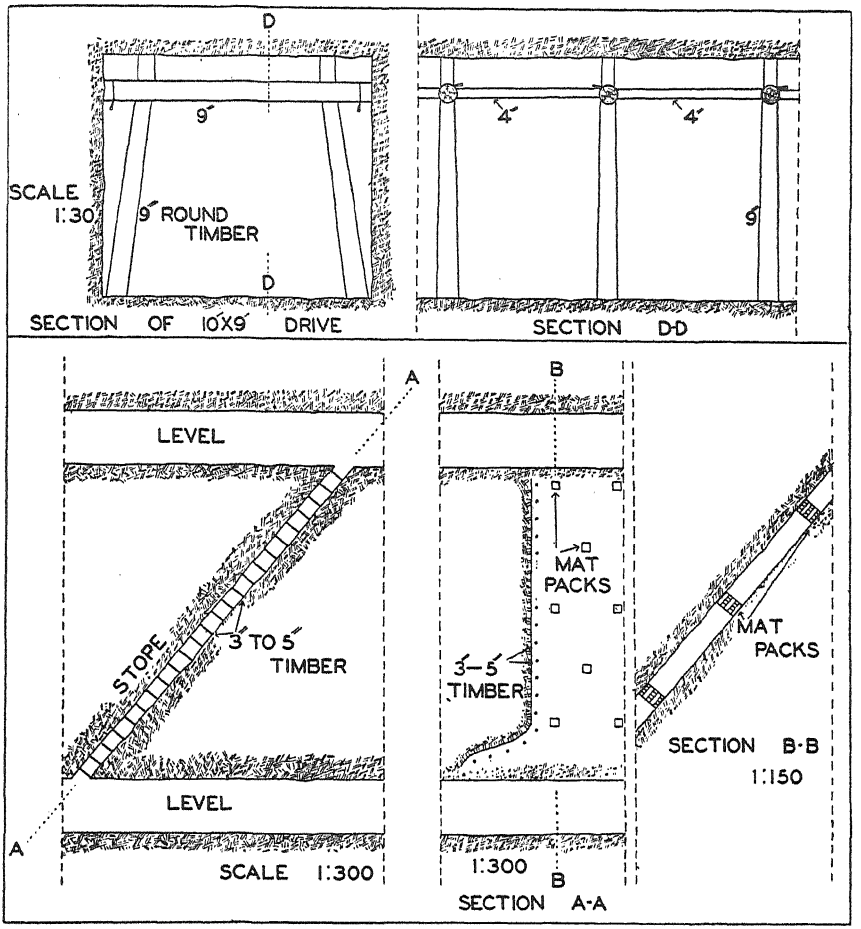


FIG. ii.—Uses of support timbers underground.

CONSUMPTION OF GUM AND WATTLE WOOD

It is impossible to find a really satisfactory basis on which to estimate the quantities used in the mines. Neither the mines nor the distributors keep a classified record of the quantities used or sold. The most reliable records would probably be the tonnage bought by distributors, but in view of the great variation that exists in the weights of timber per cubic foot, due to species, rate of growth, sylvicultural treatment, site and degrees of dryness, little indication of the volume or the number of pieces sold to the mines could be obtained by an examination of these tonnages. As an example, it may be stated that the weight of wattle wood varies from 40 to 57 lbs. per cubic foot depending on its degree of dryness and other factors. This means that a ton (2,000 lbs.) may occasionally contain as many as 50 cubic feet of dry wood, whereas, if the wood is freshly felled a ton may contain less than 30 cubic feet.

The only reliable statistics in relation to mining timber that do exist are those published by the Government Mining Engineer in his

annual reports. These are purely in the form of cost to the mines of the various classes of timber consumed. Any estimate of quantities used must therefore be based on these figures.

Each mine makes a periodic return to the Government Mining Engineer of the sums spent on various classes of timber. The data presented in Table IV are extracted from this information.

TABLE IV.

Value of Locally Grown Hardwoods Consumed by the Transvaal Gold Mines in Thousands of Pounds.

Year.	Value.		
	Poles, laggings, matpacks, etc.	Sleepers, chutes, stope box boards, wedges, etc.	Total.
1929	628	12	640
1930	632	15	647
1931	625	18	643
1932	706	26	732
1933	776	31	807
1934	877	39	916
1935	1,077	53	1,124
1936	1,187	57	1,244
1937	1,342	69	1,411
1938	1,550	75	1,625
Total	9,394	395	9,789

From this table and from confidential statistics on the prices paid by the principal mines for various classes of mining timber and from statistics compiled from several sources (some of which are admittedly unreliable) on the relative amounts of manufactured and round material consumed, it has been possible to arrive at the volume of locally-grown

TABLE V.

Volumes of Locally Grown Hardwoods Consumed by the Transvaal Gold Mines.

Year.	Volume in thousands of cubic feet.						
	Poles, lagging, matpacks, slabbed poles, etc.			Sleepers, wedges and boards for chutes and stope boxes.			Total.
	Actual.	Waste.	Total.	Actual.	Waste.	Total.	
1929	13,000	300	13,300	120	30	150	13,450
1930	13,500	350	13,900	150	40	190	14,090
1931	13,000	300	13,300	180	45	225	13,525
1932	14,000	350	14,900	260	65	325	15,225
1933	15,000	450	15,500	310	80	390	15,890
1934	16,500	750	17,300	390	100	490	17,790
1935	18,000	1,100	19,100	530	130	660	19,760
1936	20,000	1,600	21,600	570	140	710	22,310
1937	22,000	2,200	24,200	690	170	860	25,060
1938	25,500	3,200	28,700	710	180	890	29,590

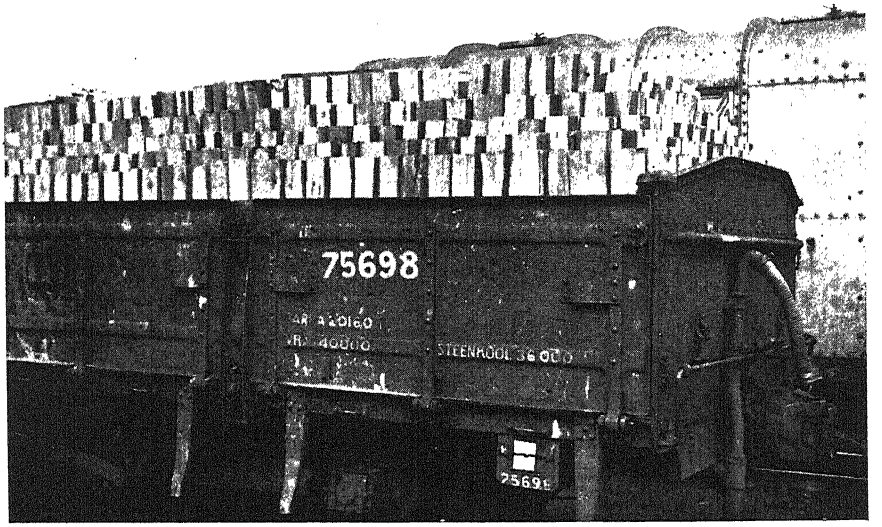


FIG. iii.—Packs sawn in the field being railed to the Rand mines. They will be threaded on iron rods to make the mats shewn in fig. i.

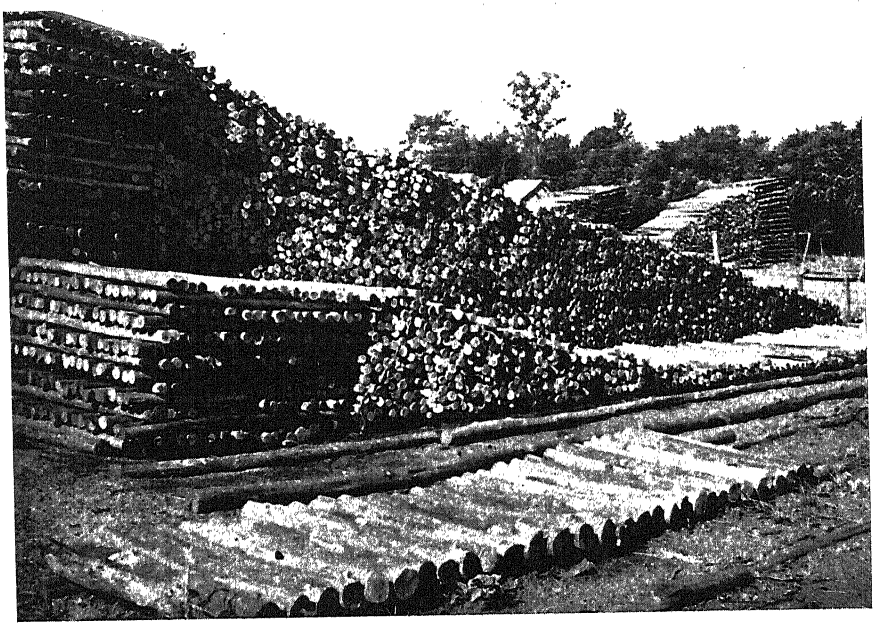


FIG. iv.—Mining poles awaiting transport to the Rand mines



FIG. v.—Typical crowns in mature black wattle stands previous to 1928.

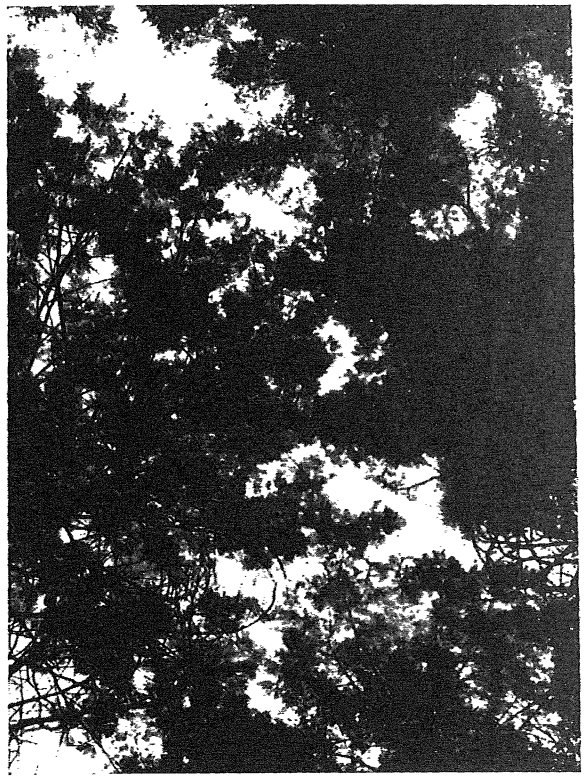


FIG. vi.—Crowding of crowns at $3\frac{1}{2}$ years with 340 trees per acre. *Acacia decurrens*, 30′ high. Cramond, 1939.

hardwoods consumed by the mines. This information is presented in Table V, from which it will be seen that the consumption of locally-grown timber used by the mines has increased from under 14,000,000 cubic feet in 1929 to almost 30,000,000 cubic feet in 1938.

If due allowances are made for the densities, degrees of dryness and for the weighted proportions of gum and wattle wood sold to the mines, a converting factor of 51 lbs. per cubic foot may be used to express the above volumes in tons marketed annually. On this basis it will be seen that the gold mines consumed approximately 757,000 tons of locally-grown hardwoods during 1938. This figure is in very close agreement with that compiled from data actually supplied by individual distributors in regard to their turnovers in tons for the same period.

Production of Gum and Wattle Wood

Area under production of mining timber.

The data presented in Table VI was extracted from the most recent (Aug. 1937) agricultural census.

The total acreages far exceed, however, the effective area producing mining timber. In certain cases the estimates submitted of existing acreages are known to be excessive, and moreover, the totals given include all small areas planted for purposes of shade, shelter or ornament. In order to determine the effective area under production it will be necessary to ignore all areas upon which the objective is not the production of mining timber or which are so inaccessible, either by road or rail, from the chief mining centres that the profitable sale of mining timber is not possible. From a study of Table VI it will be seen that the total acreage under gums and wattles in Natal, Zululand and the Transvaal (excluding state-owned plantations) up to the age of 15 years is 162,000 and 495,200 acres respectively. Due to the factor of inaccessibility these areas may conservatively be reduced by 20 per cent. for gums and 30 per cent. for wattles, giving effective areas of production of 130,000 and 340,000 acres respectively.

Wood increment per acre.

Eucalyptus saligna, which comprises at least 75 per cent. of the 130,000 acres referred to above, is a high volume producer relative to wattle. Well managed blocks of *saligna* have yielded rates of growth averaging 700 cubic feet per acre per annum for long periods of time. Increments of 350 to 400 cubic feet per acre per annum are not unusual over large areas. A conservative average estimate to cover the effective acreage under production would approximate 250 cubic feet.

The annual increment per acre for wattle is about one-third that for gums. For the purpose of yield computation, therefore, a production of 83 cubic feet per acre per annum for the average increment over the effective area producing wattle mining timber appears to be reasonable.

Discussion.

The data on production given above are summarised in Table VII. If they are compared with those of consumption for 1938, given in Table V, it might appear that there is already serious overproduction. As shown in Table VI a very large proportion of the recorded area, particularly that under gums, is so young that it has, as yet however, had no effect upon the supplies available for sale. Furthermore, it will

TABLE VI.

ACREAGE UNDER GUMS AND TAN WATTLES IN THE UNION EXCLUDING STATE PLANTATIONS.

Age class. Years.	Acreage planted.										
	Gums.					Tan wattles.					
			Total for			Private.				Municipal. Natal, Zululand and Transvaal.	Total for Natal, Zululand and Transvaal.
	Private.	Municipal.	Union.	Cape and O.F.S. (excluded).	Natal, Zululand & Transvaal.	Cape.	Natal and Zululand.	Transvaal.	Natal, Zululand & Transvaal.		
0 to 5	103,600	4,700	108,300	17,300	91,000	4,500	179,000	51,400	230,400	6,400	236,800
5 to 10	54,400	2,200	56,600	16,600	40,000	7,800	166,000	66,000	232,000	4,900	236,900
10 to 15	43,000	2,000	45,000	14,000	31,000	2,700	12,300	9,000	21,300	200	21,500
0 to 15	201,000	8,900	209,900	47,900	162,000	15,000	357,300	126,400	483,700	11,500	495,200
15 to 20	19,800	1,000	20,800	7,800	13,000	1,400	1,200	4,300	5,500	—	5,500
over 20	16,400	1,500	17,900	9,900	8,000	1,300	1,100	3,300	4,400	—	4,400
Total	237,200	11,400	248,600	65,600	183,000	17,700	359,600	134,000	493,600	11,500	505,100

TABLE VII.

ANNUAL INCREMENT PRODUCED BY EFFECTIVE GUM AND WATTLE AREAS.

Species.	Acreage.	Annual increment. cu. ft.	
		Per acre.	Total.
Gums	130,000	250	32,500,000
Wattles	340,000	83	28,200,000
Total	470,000	—	60,700,000

be seen from Table V that consumption of timber increased, during the period 1934 to 1938, by approximately 70 per cent. During the same period the volume of timber consumed per ton of ore hoisted rose by 25 per cent. While there is little evidence available in support of the view that these rates of increased consumption will be maintained during the next decade, it is evident that the probable demand during this period need not necessarily fall far short of the potential supply. On the other hand the available data show even more strongly that no further extension of plantations for the production of mining timber is warranted, for existing plantations are adequate to cope with probable future demands, even if the rate of mining is considerably accelerated.

WATTLE SILVICULTURE

Radical changes in wattle silviculture have taken place since 1928, when Craib (1) started his researches upon plantation establishment and management. At this date mature plantations outside the eastern Cape Province rarely carried less than 800 to 1,000 trees per acre. Craib was the first technical silviculturist to make a critical examination of the methods employed by private growers and companies in Natal. As a result of his work it is now extremely rare to find mature areas carrying as many as 800 trees per acre; the average now is about 500 with plantations of several of the larger private growers carrying considerably less than this. As a result of the stress laid by Craib on spacing and grass control in early life (first year) so as to avoid crown reduction because of competition, it was found safer to thin to 400 trees per acre in the first year rather than to 800 in the third year as was done previously (see figures V, VI, VII and VIII). In addition to the greatly improved weed control secured under this new system, every indication was given at an early stage that yields would be higher and bark quality improved.

There is now no responsible body of opinion amongst growers which fails to support Craib's recommendation that vigorous stands should be thinned down to 400 trees per acre in the first year. It was not necessary to secure and publish statistically valid data to support these recommendations for the improvements resulting from them were obvious.

Craib (2) went further, however. He recommended that, where optimum success had been obtained in producing trees with dense crowns, and when drought, pest or grassiness had not interfered with

crown vigour and there was no doubt about an exceptionally high rate of growth being maintained, stands be thinned further to 250 trees per acre at a height of 7 to 10 feet. Otherwise he recommended that stands should be matured at 300 to 400 trees per acre.

The results in practice.

These final recommendations were based on initial results obtained in a few experimental plots of Black and Green Wattle (*Acacia mollissima* Willd. and *A. decurrens* Willd. respectively), where the number of trees per acre had been reduced to 200 in the first year, and also, of course, on the general results obtained over thousands of acres where thinning to 400 or 500 trees per acre in the first year was being practised. On the basis of these data and examples, the final recommendations appear to have been unnecessarily cautious and overburdened with qualifications. Two hundred vigorous trees per acre at four years of age had given fully stocked stands, with complete grass control from the age of 9 months, and crowns with surprisingly small branches for the number of boles per acre. When one considers the advantages attendant on long rotations, and that the new silviculture hoped to extend the average rotation in the industry from 8 to 12 years, it will probably be agreed that Craib's recommendation of spacing to 250 trees only in very special cases, was unduly cautious.

Thinning suddenly became so popular, however, that it is not surprising to find that it was not always carried out with due regard to conditions in the plantations themselves. Many of these, which had not been thinned strictly according to the recommended technique, were suddenly thinned at the comparatively advanced ages of 2 to 4 years from 600-800 trees per acre to 250-400. When clear-felled these stands gave smaller bark yields than neighbouring unthinned areas, except where the thinnings had been sold. Other stands were thinned to their final espacement of 250 trees per acre when the mean heights of the trees were only 3 to 5 feet. The promising initial growth was not sustained and severe outbreaks of insects and pests (5) caused serious damage. Growers who suffered these experiences and reverses tend, therefore, to apply no thinning subsequent to the pen-ultimate thinning to 400 or 500 trees per acre recommended by Craib. The reasons they advance in support of this policy are fourfold :

(a) It makes provision for tree losses due to frost and insects.
(b) It controls the development of excessively large branches which cause loss of saleable mining timber due to crookedness.
(c) It produces higher yields of bark.
(d) It produces smaller average diameters and reduces taper thereby increasing the proportion of saleable timber, for these growers contend that the mines demand timber in the smaller sizes.

The Timber position.

It will now be necessary to digress in order to analyse the present position in respect of mining timber size classes.

It has already been stated that the silvicultural recommendations of the Division of Forestry are designed on a long-term basis to reduce production costs and improve bark quality. The information presented in Table VIII gives, in general terms, the effect of density of stocking on



FIG. vii.—A typical mature stand previous to 1928.



FIG. viii.—*Acacia decurrens* 7½ years old. Stocking 200 trees per acre. Mean diameter breast high 7.5″. Mean height 65′. Grass control perfect. Treated more or less as recommended in this article.

the size of the mean tree on an average site, its effect on the rotation length and the extent to which longer rotations will reduce the area to be clear-felled annually in the industry, thereby ameliorating the anticipated position regarding labour shortage.

TABLE VIII.

EFFECT OF THINNING ON MEAN TREE SIZE, ROTATION, AND TOTAL ANNUAL CLEAR-FELLING ACREAGE.

Stems per acre at maturity.	Dbh. overbark.	Probable rotation years.	Total acreage to be clear-felled annually.
500	5.5	8	42,500
300	7.0	10	34,000
200	9.0	12	28,300

From information given in Tables V, VI, VII and VIII and from data available regarding the range of diameter distribution about the mean diameter and the percentage utilization in various sizes for the range of tree diameters produced, it is possible to arrive at the information given in Table IX.

TABLE IX.

PRODUCTION AND CONSUMPTION OF MINING TIMBER.

Inch class.	Production.							Consumption.	
	Gums. (fixed regime)	Wattles. on basis of undermentioned stocking per acre.			Total. (fixed gum and undermentioned wattle regimes)			1938.	1950. (estimated).
		500	300	200	500	300	200		
2 to 2.9	1,640	2,465	1,275	622	4,105	2,915	2,262	740	900
3 to 3.9	4,200	6,080	3,200	1,641	10,280	7,400	5,841	5,180	6,900
4 to 4.9	5,770	8,460	4,725	2,688	14,230	10,495	8,453	8,730	11,600
5 to 5.9	6,560	10,120	5,580	3,365	16,680	12,140	9,925	6,370	8,500
6 to 6.9	7,470	3,910	5,475	3,877	11,380	12,945	11,347	4,140	5,500
7 to 7.9	4,420	2,635	4,285	4,610	7,055	8,705	9,030	1,480	2,900
8 to 8.9	3,605	2,550	2,920	4,552	6,155	6,525	8,157	888	1,200
9 to 9.9	1,122	260	1,445	3,310	1,382	2,567	4,432	592	800
10 to 10.9	{ 1,333	—	{ 340	2,235	{ 1,333	{ 1,673	3,568	592	800
11 and over		—		1,216			1,216	888	1,200
Total	36,120	36,480	29,245	28,116	72,600	65,365	64,236	29,600	40,300

This table will need considerable explanation. It will first be noticed that the data on the production of gum wood remains fixed. This is because gums are usually grown at an espacement of 8 x 8 or 9 x 9 feet and remain unthinned throughout the rotation (usually 8 to 9 years) and produce a mean diameter of approximately 7.5 inches at maturity on average sites. In predicting the consumption of mining timber by the mines ten years hence, an increase of approximately one-third above the consumption for 1938 is provided. This allowance is actually more optimistic than that made by the most reliable authorities as to likely future consumption. Despite the obvious uncertainty as to the reliability of these data on future consumption, they are inserted

here in order to illustrate important points. Firstly it will be seen that according to current practice, there is a demand for a large range in mine prop sizes. Secondly, the table shows that if the whole wattle industry applied a fixed thinning regime it would result in overproduction of certain sizes and underproduction of others.

In Table IX all the volumes given are based upon total volume in the log. A large amount of material actually used by the mines, however, is manufactured. The trend of the increase in the use of squared or manufactured timber used by the mines is given in Table X.

TABLE X.

PERCENTAGE VOLUME OF MINING TIMBER USED IN MANUFACTURED STATE.

Year.	Percentage.		Year.	Percentage.
1929	10		1935	25
1930	10		1936	32
1931	10		1937	40
1932	10		1938	49
1933	12		1939	55
1934	18			

Manufactured timber, as there defined, covers the 2 to 8 inch size classes, but consists mostly of 2 to 6 inch material slabbed on two sides or roughly squared. Much of it could be cut from material 9 inches or more in diameter. This applies particularly to "packs" now cut from 3½ to 5 inch material. The growing use of manufactured mining timber, illustrated in Table X, strongly supports the contention that it might be safer to produce large material which can readily be reduced to smaller sizes, than to aim at the production of small material which is not able to meet the demand for larger sizes.

If due allowances are made for the eucalypt industry and for the unlikelihood of *all* wattle growers being able to produce *only* relatively large trees in view of the anticipated loss in growth through drought, pest and disease, there is every reason to believe that the most conservative wattle thinning regime will, in the long run, tend to be also the least profitable.

The bark position

The future well-being of the South African wattle industry in general and of the demand for wattle bark in particular, is dependent almost solely upon the quality of bark exported.

Numerous experimental projects designed to collect data on the result of densities ranging from 200 to 500 trees per acre are only 2½ to 3 years old. Few of the older experimental areas, conforming with the standards of sound silvicultural technique, carry more than 350 trees per acre, for, at three years of age (see Fig. VI) plots with this density were crowded and at four years of age showed a loss of three-quarters of an inch in diameter relative to stands carrying just over 200 trees per acre; these latter plots, at this age, exhibited an unbroken and complete crown canopy. In view of the fact that rotations

of 10 to 12 years were aimed at, 250 trees per acre appeared to be the maximum number of trees that should be left and 350 the experimental extreme.

Two pilot plots (Umvoti Wattle Co., Kranskop), on a very good site, thinned according to the new method gave the following results :—

No. of trees per acre.	Mean D.B.H. Ins.	Wet bark in long tons based upon actual weight.	Percentage tannin content (estimated).
207	8.3	8.75	38
340	6.4	7.75	36

The more heavily thinned plot yielded more bark with a higher tan content (worth 5 to 10 shillings more per ton to the tanner) than the denser plot. As the plots were clear-felled at an age of 8¼ years, it is particularly significant that the increment on the more heavily thinned plot warranted its maintenance for a longer period.

While these plots do not present statistically valid proof of the results indicated, they confirm the evidence deduced from large numbers of plots 3 to 4 years old that 250 trees per acre is the maximum number that should be finally maintained on average sites in order to produce the maximum quantity and quality of bark at 10 years. The reduction in tree diameter due to the maintenance of greater densities is beyond question. Smaller diameters automatically imply reduction in bark thickness and therefore reduced tan content. As it is, moreover, essential for the industry to adopt longer rotations gradually so as to lower production costs and labour requirements per ton of bark produced, it is apparent that the only economic method of doing this is by maintaining a smaller number of trees per acre.

Further evidence of the effect of tree diameter upon bark quantity and quality for any given height is available. This evidence is based on data provided by the measurement of many thousands of trees. These data have been classified in a table from which the information given in Table XI is quoted in order to illustrate the relative relationships in the 50 foot height class.

TABLE XI.

Influence of Diameter on Bark and Tannin Production For Trees in the 50 Foot Height Class.

Dbh. overbark. Ins.	Wet bark produced per tree.	Number of trees to 10 long tons of bark.	Relative tannin production. lb.
5	36.5	614	4,310
6	50.0	448	4,680
7	66.0	340	4,970
8	87.8	250	5,170
9	110.0	195	5,340
10	137.0	164	5,500

The tannin content of average quality South African bark on the basis of a 12.5 per cent. moisture content, as determined by the International Method of the Leather Trade Chemists, is approximately 35.5 per cent. Assuming a price of £7 0s. 0d. per ton f.o.b. Durban, one pound of tannin may be valued at approximately 1s. 9d. On this basis the value of the fixed weight of bark referred to in Table XI varies approximately from £37 14s. 0d. to £48 2s. 0d. This analysis further supports the thinning policy referred to.

Recommendations

It is not proposed to make an exhaustive statement now upon all aspects of plantation establishment and management. These vary according to local conditions and are often influenced by the experience of individual growers or managers of wattle estates. In broad principle, however, the more salient features of wattle silviculture are more or less fixed as follows :—

Thinning

The following thinning schedule will apply where the production of relatively large trees accompanied by bark of high quality are the objects of management. Allowance is made for losses due to cutworms, cockchafers, eelworm and white ants during the first few months in the life of the plantation, and for losses due to root-collar rot and withering or Albert Falls disease during later periods.

Height of trees.	Spacing or thinning prescription.
3 to 4 inches	Space the seedlings 3 to 4 feet apart in the rows irrespective of the row espacement.
2½ to 3½ feet	Space the trees 12 to 15 feet apart in 6 to 8 foot rows or closer if the width between the rows is greater, or, in other words, leave 500 to 600 trees per acre, distributed as evenly as possible.
7 to 10 feet	Leave 300 to 350 of the best trees per acre. Delay thinning if a severe attack of froghopper is expected and dusting with pyrethrum is not possible.
15 to 20 feet	Thin to a maximum of 250 trees per acre in areas where a height growth of more than 50 feet is expected at the end of the 8th year. In many cases this reduction will have occurred automatically, due to disease, by the end of the 2nd year.

A progressive policy of thinning along these lines will allow a sufficient extra number of trees per acre to replace casualties and yet avoid loss of growth due to any marked degree of suppression.

Pruning

This operation has been introduced into plantation work comparatively recently. It has in many cases been much overdone.

Pruning is necessary only in the case of forks or of branches which, due to some injury to the leading shoot or due to some upset in the physiology of the tree such as results from froghopper attack, start to grow vertically and compete with the leading shoot.

Pruning should normally commence after the second spacing operation. Early pruning may be done with small hand-pruners; later when the trees are over 5 feet in height pruners with handles 20 inches long are more convenient. For pruning branches considerably more than 6 or 7 feet above ground, a pruner on a long pole has to be used. The small hand pruner is able to sever branches up to ¾ of an inch in diameter and the other two up to 1¼ inches.

Pruning should be done as close to the stem as possible without injuring the bark, but where pruning has been delayed and the branches have become too thick, pruning a little distance from the stem is permissible.

Fertilising

Under normal conditions in practically all areas where wattle is grown, rate of growth in early youth (first 18 months) appears to be determined by the amount of available phosphorus in the soil. Applications of quite small amounts of superphosphates have the most marked effect in accelerating height growth and crown volume. In fact, for the maximum success of the thinning regime detailed above, it is essential that superphosphates should be applied. Apart from the increase in the amount of bark and timber produced (a net value per acre of approximately £3 or £4), earlier and more complete control of weeds is obtained. This often saves the necessity of a late weeding or avoids loss of vigour which might otherwise result from the presence of weeds that develop after normal weeding operations have ceased. In addition, for any given degree of insect attack, the adverse effects are less because the volume of foliage present is greater.

The most marked increases are obtained from the application of 100 to 250 lbs. of 19.1 per cent. superphosphate per acre. Heavier applications have usually a comparatively small additional effect. After the first 18 months, when root competition between individual trees becomes severe, moisture is apparently the principal factor which limits the rate of growth.

Fertiliser is best applied in two applications. Unless taken up fairly soon by the plants, much of the available phosphoric oxide becomes unavailable due to the formation of insoluble iron phosphate. The rate at which this occurs will, of course, depend upon the soil and seasonal conditions. 75 to 125 lbs. per acre, depending upon row espacement should be applied on the seed beds at the time of sowing and the balance after the second spacing. In cases where natural germination is so prolific that sowing is unnecessary or where as often happens with sowing and fertilising in spring, the weeds develop much faster on the fertilised rows than on the balance of the area, making weeding and spacing difficult, it is often best to apply the fertiliser as near the rows as possible after germination has taken place.

The use of raw rock phosphates either alone or in combination with superphosphate has been disappointing. The application of the mixture at the time of planting is not recommended. If applied broadcast, the superphosphate will be applied over too great an area to be of much

use to the seedlings. If applied in a band on the seed bed, the application of the raw rock phosphate will be too localised. If raw rock phosphate is to be used at all, it would seem best to apply it broadcast at the time of sowing. If delayed action is required, however, granulated superphosphate will probably give the best results.

Applications up to 100 lbs. of potash have not given the same results either in consistency or magnitude as that of superphosphate, but as data on this subject accumulate, it may yet be found that fertilising with potash will be profitable.

Hoeing.

All grasses and weeds should be hoed out prior to sowing and kept rigidly under control until the trees are 5 to 6 feet high. Thereafter, it is only in cases of severe froghopper attack or other adverse factors that the removal of annuals, even perennials, is necessary. One light hoeing after the original cleaning is often sufficient, though frequently two, three or more light weedings may be necessary. Subsequent wattle regeneration should at all times be removed.

Lack of proper weed control rather than any other factor is more often the cause of failure to secure the best results. Unless weeds are strictly controled by light weedings, fertiliser will be lost and the trees will lose a degree of their power of responding to treatment. Delayed weedings or heavy weedings mean further loss of vigour due to grass competition and root injury. It is essential to keep weeds down rigidly until the trees are 5 to 6 feet high and for a longer period if the row espacement is very wide.

Rotation length.

The silvicultural prescriptions elaborated here are devised in order to prolong the period of high bark and wood increment. The possibility of increasing the length of the rotation from the normal period of 8 years to a minimum of 10 years, and in special regions to 12 years or even longer, has very marked advantages. It may not be out of place here to enumerate a few of the advantages of longer as opposed to shorter rotations.

(a) Higher yields per acre.
(b) Smaller area to be clear-felled for a given quota of bark.
(c) Lower re-establishment charges for a given quota of bark.
(d) Less labour required for re-establishment purposes. Shortage of labour at the critical time in plantation initiation is becoming more and more serious.
(e) Higher bark quality.
(f) Less frequent exposure of the soil to the direct rays of the sun and therefore less chance of sheet erosion.

Discussion.

The necessity for fertilising and weeding will be obvious to everyone and no grower would, designedly, wish to depart from these recommendations. The necessity for adhering strictly to the thinning schedule is not so widely accepted.

A large number of growers maintain that should it ever become obvious to them that stockings of 500 trees per acre are too dense, they will be able to thin further in the third year. These growers should,

however, take warning from the fact that all available evidence goes to show that, on account of the depressing effect which such delay has both on the actual mean diameter and on its future rate of growth, the results are relatively disappointing. This would, of course, be counteracted to some extent if the bark and timber from the thinnings were saleable. Such bark, however, is quite unsaleable. The principle on which successful thinning in wattles is based is that under average conditions in the industry, the species is essentially intolerant of competition and thinnings must therefore anticipate competition and not wait for such competition to be apparent.

It is conceivable, however, on certain favourable sites, where the thinning has been carried out as suggested to 250 or 300 trees per acre, that it may be found possible to thin further to 175 or 180 trees per acre in the 6th year and leave the remaining trees to an age of 12 years or more. This possibility, however, is still in the purely experimental stage.

Data, relevant to this point, are available from a series of Green Wattle plots (Cramond, Albert Falls) which were similarly treated according to the above recommendations up to the age of 4 years. At this age a number of the plots were thinned to an average of 160 trees per acre. Wind damage has gradually reduced the stocking to 140 trees per acre. The heavier stocking also suffered wind damage but to a lesser extent. The thinnings yielded 1½ tons of wet bark which, if it had been from black wattle of the same size would have been of average quality, and 4 tons of dry timber. The bark and timber together if sold would have produced a net return per acre of £2 10s. 0d. to £3 0s. 0d. At the age of 7½ years the thinned plots still carried a lower standing yield than the unthinned plots, though the latter were lower in total yield. An intermediate return of this nature would be a significant advantage to the private grower and would help to lengthen rotations materially. The poor demand for the bark produced at these earlier ages for the purpose of extract manufacture on account of a possible high ratio of soluble non-tannins to tannins and the undesirability of exporting this quality of bark when a superior quality is being aimed at, are, however, all serious disadvantages to the development of the principle of intermediate yields. Nevertheless, in view of the encouragement which would be given to the adoption of longer rotations as a result of the marketing of an intermediate yield, this possibility is still under investigation.

Summary

The mining timber industry is analysed from the point of view of the grower of mining timber. Consumption and production in size classes are indicated as well as the relative percentages used in the round and manufactured. The conclusion is drawn that wattle growers should aim at larger mean diameters so as to spread production over a greater range of size classes than is covered at present. This may produce a slight deficiency in the future demand of one or two of the smaller size classes, but due to the fact that a large percentage is manufactured, these deficiencies may be made up from surplus production in the larger size classes.

Recent trends in wattle silviculture are discussed from this point of view and the salient features of current recommendations are indicated.

ACKNOWLEDGMENTS

Thanks are due to the large number of distributors of mining timber who willingly provided much of the information upon which this paper is based. Special acknowledgment is perhaps due to the Northern Timber Company for data provided by their technical services and to the Exchange Yard Proprietary whose model records were an invaluable basis for much of the data given here.

LITERATURE.

(1) CRAIB, I. J. : "The Place of Thinning in Wattle Silviculture and its Bearing on the Management of Exotic Conifers." *Zietsch. fur Weltforstwirtschaft.* Bd. 1, Heft 2/3. 1933.

(2) ..... "The Wattle Industry in South Africa." Brit. Emp. For. Conf. S.A. 1935.

(3) KOTZE, J. J. : "Forestry in Relation to the Mining Industry of the Witwatersrand." *S.A. Jour. Sci.* Vol. xxxiii, pp. 359-361. 1937.

(4) REID, H. A. : "Mining Timber on the Witwatersrand."*Emp. For. Jour.* Vol. 8, No. 2. 1929.

(5) STEPHENS, R. P. and GOLDSCHMIDT, W. B. : "A Preliminary Report on some Aspects of Wattle Pathology." *Jour. S.A. For. Assoc.* No. 2, April, 1939.

(6) WATERMEYER and HOFFENBERG : "Witwatersrand Mining Practice."

'N BESOEK AAN DIE VERENIGDE STATE SE BOSPRODUKTE LABORATORIUM TE MADISON

DEUR D. P. ACKERMAN

DIE BOSPRODUKTE Laboratorium, wat in 1910 te Madison opgerig is deur die Landboudepartement van die Verenigde State in samewerking met die Universiteit van Wisconsin, is die brandpunt van bosprodukte navorsing in Amerika. Sowat 'n jaar gelede het ek die geleentheid gehad om die Laboratorium te besoek en mnr. J. B. Cuno, skrywer van verskeie pamflette oor bosbenutting, het my deur die verskillende afdelings geneem.

'n Indrukwekkende moderne gebou van beton en glas, geleë in ruim gronde, gee huisvesting aan die uitstekend toegeruste laboratorium, waar nog voortdurend goeie vordering gemaak word in beide praktiese en akademiese navorsingswerk.

Die Laboratorium het reeds ruimstreeks bygedra tot die vinnige ontwikkeling van die pulp- en papiernywerheid, en ondersoekingswerk in hierdie verband vind nog steeds plaas. Die volledige toerusting sluit 'n klein houtpulpskuurder vir meganiese pulp in, asook 'n spaander-kapper en klein kommersiële verteer-ketel vir grootskaal eksperimente, twee ketels van semi-kommersiële grootte vir suur en alkaliese prosesse onderskeidelik, drie klein autoklaafs vir werk op laboratorium skaal, 'n paar pulp-kloppers van verskillende tipe en grootte, en 'n eksperimentele Fourdrinier papiermasjien waarop 'n twaalf-duim papierstrook kan vervaardig word. Hierdie uitrusting maak dit dus moontlik om verskeie pulpmetodes op 'n houtsoort toe te pas en stel die tegnikus in staat om die eindresultaat van sy werk in die vorm van papier te sien. Addisionele apparaat maak dit ook moontlik om die eienskappe van die papier meganies te toets.

Op die gebied van hout-preservering kan navorsing nog nie beskou word as voltooi nie, en daar word selfs gesoek na verdere verbeterings op die gewone handelsprosesse, almal waarvan in die laboratorium kan nageboots word. As 'n roetinesaak word enige nuwe preserveermiddels wat op die mark mag verskyn aan streng toetse onderwerp. Gedurende my besoek was 'n demonstrasie aan die gang van die „Binneband metode," 'n eenvoudige toepassing van een van die vroegste houtpreserverings prosesse, soos oorspronklik ontwerp deur Boucherie in 1839. 'n Ry varsgekapte pale, met bas aan, word op 'n stellasie geplaas sodat die dun-ent van elke paal 'n paar voet laer lê as die dik-ent; 'n stuk ou moter binneband word dan vir 'n paar duim oor die dik-ent getrek en vasgebind; die oop kant van die binneband word gelig en aan die stellasie vasgemaak sodat dit 'n reservoir vir die preserveermiddel vorm. Laasgenoemde stroom dan onder die invloed van die swaartekrag deur die houtvate en neem die plek in van die natuurlike sap in die spint-hout. Die behandeling duur tot die teenwoordigheid van die preserveermiddel kan vasgestel word aan die dun-ent van die paal.

Voorsiening word ook gemaak vir werk in verband met die

meganiese eienskappe van hout. 'n Groot saal bevat 'n aantal masjiene vir proewe met houtmonsters van standaard grootte en tydens my besoek was hierdie masjiene in gebruik vir roetine toetse op monsters afkomstig van bome wat in die groot orkaan van September, 1938, omgewaai het. Meer as 600,000 toetse, om die meganiese eienskappe van sowat 160 Amerikaanse houtsoorte te bepaal, was toe reeds voltooi. Die saal bevat ook 'n reuse toets-masjien wat in staat is om 'n druk van 'n miljoen pond uit te oefen, en dit word gebruik om dak-kappe, kolomme, balke, opgeboude panele, en ander struktuureenhede as geheel te toets.

Die Madison Laboratorium kan roem op die besit van tien van die volledigste droogoonde wat ooit vir navorsingsdiens in gebruik gebring is. In die verlede is belangrike werk reeds gedoen met die opstelling van droogskedules vir weerbarstige houtsoorte, maar op die oomblik word ondersoek veral gemik op 'n min of meer akademiese studie van die faktore wat die beweging van lug in 'n droogoond beinvloed. Melding kan ook hier gemaak word van die gebruik van sout by die droging van groot Douglasfir balke. Die eksperimentele werk in hierdie verband is langs die Weskus van die Verenigde State, waar omstandighede vir lugdroging nie altyd gunstig is nie, onder leiding van die Madison Laboratorium uitgevoer. Die balke word vir 'n tydjie in 'n oplossing van gewone sout geweek en dan gepak vir lugdroging. Die osmotiese spanning deur die sout veroorsaak versnel die beweging van vog in die balk, en die higroskopiese effek vertraag effens die uitdroging van die oppervlakte. Groot verskille in voggehalte tussen die buite- en binnelae van die balk word dus vermy, en die inkrimping wat gepaard gaan met die uitdroging van die hout vind as gevolg baie egalig plaas. Dit word beweer dat hout van groot afmetings na soutbehandeling kan gedroog word sonder om die barste en ander drogings-swakhede te ontwikkel wat dikwels kenmerkend is van sulke balke.

Die Laboratorium doen belangrike adviserende werk in bosbenutting, veral in verband met klein saagmeules. Pamflette oor die tegniese en ekonomiese aspekte van ontginning en vervaardiging verskyn gereeld, en nadruk word veral gelê op die grens-grootte van die boom vir ekonomiese benutting. Aangesien hierdie ekonomiese grens beinvloed word deur 'n verskeidenheid van plaaslike faktore is dit nie moontlik om algemene gegewens toe te pas nie, en beamptes van die Laboratorium doen dus in verskeie streke gedurig veldstudies in hierdie verband. As voorbeeld van die uiteenlopendheid van die uitslae, vind ons dat dit in Suidelike Maine moontlik is om blokke met 'n deursnit so laag soos 5 duim ekonomies te ontgin en verwerk, terwyl dit in die Westelike Sierra-berge van Kalifornië gevind word dat, met die gebruik van bos-spoorweë, 23 duim die minimum betalende grootte is vir ,,sugar pine." Deur die vasstelling van 'n arbitrêre seleksiestelsel, met minimum deursnit as kapgrens, het hierdie benuttingstudies aansienlik bygedra tot bevordering van die houtteelt in Amerikaanse inheemse bosse.

Die sukses waarmee hout teen sy plaasvervangers konkureer hang grotendeels af van die ontwikkeling van beter metodes van houtverbruik. Op Madison word gewerk met saamgestelde hout balke, boë, en dakkappe vir groot geboue. Dit is reeds bewys dat konstruksie werk met metaal verbindings, soos ,,Teco" of ,,Alligator" gesplete of getande ringe, sterk en ekonomies is, en die jongste ontwikkelings toon aan

dat boogvormige dakkappe van gelymde konstruksie nie alleen van toepassing is waar 'n goeie voorkoms verlang word nie, maar ook verbasend sterk is.

Die Laboratorium het ook 'n vooraf-vervaardigde huisbou-stelsel ontwerp, wat gebruik maak van standaard panele, elk bestaande uit 'n ligte hout raamwerk aan weerskante waarvan waterdigte laaghout gelym is. Die gelymde konstruksie versprei alle spannings eweredig oor die hele paneel en maak dit moontlik om die huis met 'n ligte raamwerk te bou. Die tussenruimtes in die panele kan met 'n isoleermiddel soos asbes gevul word, en toetse het reeds getoon dat so 'n huis bestand is teen hitte, koue, en vog. Twee aantreklike huise, volgens hierdie beginsels gebou, staan in die gronde van die Laboratorium, en word teen die kwaai winters van Madison met 'n betreklike geringe verbruik van brandstof verhit.

Eksperimentele werk van 'n ander aard het uitgeloop in die produksie van 'n nuwe plastiese materiaal, vervaardig met lignin as grondstof. Saagsels word met sure hidroliseer, en die sellulose sodoende verwyder: daarna word die oorblywende lignin behandel met furfural en onder hoë druk en temperatuur saamgepers tot enige verlangde vorm.

Mnr. Koehler, deskundige op die gebied van houtfisika, hou hom besig met die gevolge van houtteeltkundige behandeling op die fisiese eienskappe van hout. Monsters word vertoon wat die besonder groot lengte-inkrimping van seker dennesoorte met groeiringe wyer as 'n kwart duim wys, en die rede hiervoor word onder die mikroskoop gesoek. Mikroskopiese werk word ook gedoen om die oorsaak te vind van die eienaardige eienskappe van „kompressie hout," d.w.s. die swaar, rooierige hout wat aan die onderkant van takke en skuinsgroeiende stamme van sekere keëldraende soorte voorkom, asook die eienskappe van hout uit die geswelde stamme van bekende loofhoutsoorte as die bome in vleigrond groei.

Terselfdertyd, onder leiding van die bekende plant-anatoom dr. Ritter, is belangrike werk reeds gedoen op die gebied van mikrostruktuur van hout, veral met verwysing na die aard van die ultra-mikroskopiese drade waaruit die selwand bestaan.

Van meer onmiddellik praktiese toepassing is die proewe wat gedoen word met verfstowwe, wat plaaslik aangemaak en getoets word teen blootstelling aan wind en weer of aan die strale van 'n lamp wat die effekte van sonlig geweldig vergroot. Die beste waterdigte bedekking blyk aluminium verf te wees, en dit word gemeen dat die klein metaal-deeltjies daarin oormekaar lê soos die skobbe van 'n vis en dus die oppervlakte verseël.

Die fasiliteite van die Laboratorium sluit verder nog in 'n reeks stoorkamers waar klimaatstoestande, wat met dié van die trope of poolstreke ooreenkom, kunsmatig bewerkstellig kan word; 'n fotografiese departement met donker kamers en toerusting vir fotostatiese reproduksie; 'n klein saagmeul; en 'n volledige werkswinkel.

Al die kennis wat in dertig jaar van navorsing aangaande houtbenutting versamel is, is beskikbaar vir die publiek. Die inrigting se strewe is om die publiek daartoe te help om die land se bosrykdom op die doeltreffendste en mees bevredigende wyse te gebruik, en aldus by te dra tot die bevordering van bosbou soos dit opgevat word in die leuse „Bosbou is die bewaring van bosse deur verstandige verbruik."

THE CAROB OR LOCUST TREE (*CERATONIA SILIQUA*, L)

By E. E. M. LOOCK

(Forest Research Officer, Pretoria)

IN a country like South Africa, where droughts are frequently experienced and the feeding problem during the dry periods is difficult of solution, the establishment of this valuable evergreen tree as a source of a highly nutritious stock feed is worthy of consideration. The tree deserves to be more extensively tried on farms situated in areas where the climatic conditions are suitable for its successful propagation.

The scientific name of this tree is *Ceratonia siliqua* and its usual common name is the Carob tree, but it is also known by other names such as Algaroba, Locust Bean and St. John's Bread.

This tree, which is indigenous to Syria, was well known in Biblical times as it was then supposed to be common both in Syria and Judea. According to P. Gennadius, late Director of Agriculture, Cyprus, it is indigenous also to the Northern coasts of Africa. Its pods are reputed to have constituted the locusts and honey which supported St. John the Baptist in the wilderness, the seeds being taken to represent the locusts and the sweet pulp round the seeds the honey, but it must be admitted that the literal interpretation of these terms is far more plausible. It is also claimed that these pods were the husks fed to the swine on which the prodigal son subsisted during his self-imposed exile.

The cultivation of the Carob tree began in historic times when it was introduced by the Greeks into Italy and carried by the Arabs west as far as Spain and Morocco. At present it is to be met extensively, either in its wild or cultivated state, on the warmer coasts of the Mediterranean and especially in Syria, Cyprus, Palestine, Greece, Asia Minor, parts of Italy, France, Spain, Portugal and the North coast of Africa, where the climate is congenial to it.

As far as is known the first introduction of this species into South Africa took place about 1870, when a bag of commercial locust beans was imported from England and the seed distributed with special instructions to sow it *in situ*. Some trees were raised from this stock in the Albany district, Cape Province, and when last reported on some were bearing excellently. More seed was imported subsequently and the tree is now to be found growing in many localities from the Cape Peninsula to the Zoutpansberg.

Description.

The Carob tree belongs to the sub-family *Caesalpinieae* of the family *Leguminosae* and is the only known species of the genus *Ceratonia*.

It is an evergreen longlived tree attaining under favourable conditions a height of 40 to 50 feet or more. Its leaves are paripinnate,



Ceratonia siliqua L. (Carob).— Corner of Church and Hamilton Streets, Pretoria.

composed of 4 to 8 and rarely more leaflets, which are oval, entire, leathery, dark green and smooth above and paler below. The flowers, which are small and of greenish colour when open, appear in small, red, lateral racemes, bearing 30 to 60 flowers or sometimes more. These racemes are usually borne on branches which are more than one year old. The flowers are succeeded by flat pods from 6 to 12 inches long and about one inch wide when fully developed. The pods contain numerous small seeds arranged in a line along the centre of the pod, each seed being contained in a separate cell formed by the fleshy pulp of the pod. The Carob is a polygamo-trioecious tree, or, in other words some trees bear only male flowers, others only female and others again only hermaphrodite flowers.

Uses of the fruit.

The Carob tree is chiefly cultivated for its fruit or pods which have long been used as a first class food for cattle but have also served to a lesser extent as food for the poor in times of scarcity.

On account of the abundant sugar and great quantity of nitrogenous and other digestible substances contained in the pods when ripe, it forms a very nutritious and fattening food, suitable for pigs, sheep, goats, cattle, mules and horses. Pigs may be fed almost exclusively on these pods, but they should be mixed with an equal portion of hay, straw, barley or oats for other animals.

In certain countries Carob pods are also used in large quantities for distillation, and the spirit obtained is considered to be much superior to that produced from other amylaceous substances and sugar beetroot. According to an analysis made by Mezzadroli in Italy it contains about 40 per cent. of sugar, and 100lbs. of these pods will yield with proper treatment from 4 to 5 gallons of spirit or alcohol.

Carobs are also used in the preparation of refreshing beverages, bread, and sugar-candy, while the seeds are used for making gum and paints, and as a substitute for coffee.

Climatic and Soil Requirements.

This tree is very hardy and will thrive on almost any kind of soil provided that it is not very wet, but it prefers a deep porous and well drained soil. Owing to the development of a very long taproot it can resist droughts exceedingly well. It also prefers a warm climate, the range being about the same as that of the orange, but with little protection for a few winters the range can be considerably extended. Some varieties will even survive temperatures of 18 to 22 degrees of frost.

Although the species belongs to the winter rainfall areas, some very good specimens are to be found in the summer rainfall areas, such as, for instance Pretoria, where absolute minimum temperatures of about 20°F. are experienced.

Propagation.

The Carob tree is easily propagated by seed, but, owing to the hardness of the seed-coat, the seed should be placed in boiling water, which is then allowed to cool off while the seeds are kept soaking, before sowing.

Young trees do not transplant well when raised in beds on account of their long taproots, which are usually injured in the process of taking the plants out, and even if such plants do grow they will not be able to develop taproots suitable to resist continual droughts. It is therefore advisable, in order to obtain robust trees, either to sow the seed *in situ* or to raise the plants in one-gallon paraffin tins cut in half. When the latter method is resorted to, the plants should be planted out, when about 6 to 9 inches high, by cutting the tins open and placing the trees with soil and roots intact into specially prepared pits about 20 feet apart. Plants should be watered regularly during dry periods until well established.

Under favourable conditions, seedling-trees may be expected to come into bearing when about 6 to 8 years of age and grafted trees in their third or fourth year after grafting. (Age of stocks also about 6 to 8 years). The annual crop is at first very small, but increases rapidly as the age and size of the trees advance.

On account of the trioecious habit of this species certain trees (the males and hermaphrodites) produce little or no fruits. In order to ensure heavy crops on all the trees, except the few males which are left in the plantations to fertilize the others, seedlings are grafted in Europe with scions taken from good pod-producing strains, the idea being to get trees bearing almost exclusively female flowers.

The only grafted trees in South Africa, as far as is known, are two at Kirstenbosch near Cape Town. These originated from scions secured from a heavy bearing seedling tree in Pretoria which were grafted onto seedlings in 1921. Up to 1938, however, the two grafted trees failed to yield heavier crops of fruit than the seedling trees, in fact, the best of the seedling trees are quite as good in bearing qualities as the grafted trees. Both produce good crops of good-sized pods annually. Attempts to import grafted trees or cuttings from Europe have hitherto failed due to the fact that they arrive in a dried out condition after the long journey.



Stem of 23 year old *Eucalyptus saligna* at Rooikoppies Plantation, Tzaneen. Breast height diameter approximately 33″.

KORRESPONDENSIE
CORRESPONDENCE

EUCALYPTUS SALIGNA—PLEA FOR A LONG TERM POLICY.

To the EDITOR.

Sir,

The planting by private enterprise during the last 20 years of considerable areas of *E. Saligna* has been of great economic importance to the Union. It has resulted in the production of large quantities of mining timber for the Witwatersrand mines and has supplied an ever growing volume of traffic for the South African Railways as well as employment for cutting and haulage contractors, millhands, etc. To some districts it has brought a good measure of prosperity.

It is not my purpose to deal in this letter with the sylivicultural details. It is sufficient to say that there are several important and widely separated districts in the Union where the climatic and soil conditions are such that this exotic tree can be successfully grown.

My plea is that in handling his plantations the grower has in many instances been content to sell the whole of his plantations as mining timber and that there is little evidence of the long view.

Admitting that most *Eucalyptus* species require a fairly long period to reach maturity and that timber suitable for sawing can hardly be produced under a period of 40 to 50 years, this is not so with *E. Saligna* which at 25 to 30 years will produce logs of sufficient size and quality to justify the claim that a first class commercial semi-hardwood can be put on to the market in competition with imported hardwoods. *E. Saligna* in certain parts of the Union, grows faster than in its natural habitat, nor does the quality of the wood suffer.

The grower has thus before him a very definite choice. Is he to gut his plantations to supply mining timber or can he by adopting other methods ensure that he will have timber for the market almost continuously?

I suggest that by foresight the latter objective is attainable.

By allowing a relatively small proportion of his trees in avenues and selected blocks to escape the woodman's axe, he will be able in a little over 20 years to see supplies of logs which will produce a steady revenue for many years.

There are variations of such a policy as will be seen when the uses to which this valuable tree has already been put are examined.

There is already a large demand for heavy poles for electric transmission standards, telephone and telegraph poles, builders' scaffold poles—saligna piles have been successfully used at Capetown harbour —this demand can be met from trees say 10-15 years old. The immature wood is being used for fruit boxes, crates, etc. It may be possible to produce plywood. The mining timber market will continue to absorb large quantities of smaller stuff.

The growing, however, of large timber maturing in 20 to 25 years will provide in due course fine timber for furniture and cabinet making and the hundred and one uses to which imported hardwood is now put.

An average of 10 large trees per acre would mean to the grower of 100 acres 1,000 large trees averaging probably 4 to 5 tons each.

As pointed out such trees can be grown in avenues and selected patches without interfering with the growth of mining timber and with no appreciable reduction in the grower's present revenues.

Thus there emerges the following long term policy—

(a) To continue to grow mining timber.

(b) By proper methods to allow trees to reach the ages 10 to 15 years to supply transmission telegraph and other poles.

(c) To permit trees in selected positions to reach maturity—25 to 30 years.

Let the timber grower be content to cast a little bread upon the waters.

The following extract is taken from *The Timber and Forest Products of Queensland* by E. H. F. Swain :

> In Queensland, saligna is known as the rose gum from its resemblance in maturity to Bombay rosewood (*Dalbergia latifolia*). Whilst very large trees are recorded up to 6 ft. in diameter, the normal diameter of a tree 120-150 feet in height is approximately 3-4 feet. The weight of the mature timber varies from 40-60 lbs. per cubic foot in accordance with the condition of growth, with an average of 52 lbs. Saligna timber has been used in Queensland for railway sleepers, having a life (untreated) of 13 years compared with 22 years for ironbark.

The following uses to which the timber has been put in Australia are given: General building trade, wall plates, scantling, battens, internal flooring and lining. It is stated to be popular in Brisbane for weather-boards and non-slip hardwood steps and to be the best timber for shingles. It is often used for rails and palings. The immature wood is used extensively for fruit boxes and for inexpensive cabinet work. The advantages and disadvantages of the timber are set out by the writer in the following terms:—

> Its special advantages are rich colour, comparative lightness and ease of working for a hardwood and its abundance and cheapness.
> Its disadvantages are the variation in weight and density of different supplies, the high percentage of moisture of the green wood and the somewhat extensive shrinkage in seasoning and accompanying warping involving more careful drying than is regarded necessary for most hardwoods. It needs seasoning and would be at its best quarter-sawn.

There is a profitable timber industry in sight—if the growers will produce the timber.

Yours faithfully,

H. A. READ.

GOEDKOOP DOKTORSGRADE IN DIE BOSBOUWETENSKAP

Aan die REDAKTEUR.

Meneer,

Gedurende die laaste paar jaar het verskeie bosboustudente die onderskeiding van „Dokter in die Bosbouwetenskap" verwerf, en beklee tans almal betrekkings in die Suid-Afrikaanse bosboudiens. Dit is

inderdaad verblydend om te konstateer dat belangstelling in die bosbouwetenskappe hier in Suid-Afrika reeds tot so'n mate gevorder het, omdat spesialisasie natuurlik altyd die prestige van die bosboudiens in die algemeen en die bosbouwetenskap in die besonder, bevorder.

In Europa en ook elders is dit goed bekend dat die opvoedkundige standaard vir die bosbouwetenskap reeds 'n baie hoë peil bereik het. 'n Student wat hom in die bosbouwetenskap wil bekwaam moet eers verskeie jare in die basisvakke van die bosbouwetenskap (wat ook verskeie vakke van die natuurwetenskap insluit) studeer en die nodige esamens aflê voordat hy bevoeg geag word om selfstandig 'n bosboukundige onderwerp aan te pak en 'n oorspronklike verhandeling, na aanleiding van navorsingswerk, daaroor te skryf. Op grond van so'n tesis kan aan hom dan die graad : ,,Dokter in die Bosbouwetenskap'' toegeken word. 'n Normaal begaafde persoon kan hierdie onderskeiding gemiddeld na 6 of 7 jaar akademiese studie verwerf.

Helaas blyk dit nodig te wees dat 'n waarskuwing uitgespreek moet word om te voorkom dat daardie prestige, waaraan almal wat die bosbouwetenskap in hierdie land help opbou, nie verkleineer of belaglik gemaak word nie.

Die graad van ,,Dokter in die Bosbouwetenskap'' is, en word aan sekere oorsese universiteite byvoorbeeld onder die volgende omstandighede aan Suid-Afrikaanse studente toegeken :

'n Student wat 'n driejarige B.Sc.-kursus in die *natuurwetenskappe* deurloop het kan vir 'n tydperk van ongeveer twee jaar aan 'n oorsese universiteit direk aan 'n sogenaamde ,,tesis in bosbou'' gaan werk, sonder om vooraf enige eksamens af te lê wat hom 'n diploma of graad in die basisvakke van die bosbouwetenskap besorg. Op grond van slegs 'n tesis word dan die graad : ,,Dokter in die Bosbouwetenskap'' toegeken. So'n doktersgraad kan dus na ongeveer vyf jaar akademiese studie behaal word!

Ook kan 'n student wat ongeveer drie-en-'n-half jaar studeer het aan 'n vierjarige B.Sc.-bosboukursus, wat die voornoemde basisvakke insluit, sonder om sy kursus te voltooi of die B.Sc.-graad na afloop daarvan te behaal, na so'n oorsese universiteit gaan. Nadat hy daar vir 'n paar maande oor 'n baie algemene onderwerp aan 'n sogenaamde ,,tesis in bosbou'' gewerk het kan aan hom, sonder dat hy vooraf 'n diploma of graad in die basis-vakke van die bosbouwetenskap verwerf het, op grond van slegs 'n tesis, die volleerde graad van ,,Dokter in die Bosbouwetenskap'' toegeken word. So'n doktersgraad kan dus ook na ongeveer vier jaar akademiese studie behaal word.

Indien 'n persoon met laasgenoemde kwalifikasie 'n betrekking in die Suid-Afrikaanse bosboudiens wil aanvaar, moet hy egter as ,,Dokter in die Bosbouwetenskap'' eers sy B.Sc.-bosboukursus voltooi en as hy nie aan die eksamenvereistes, wat deur die akademiese standaard van die universiteit gestel word, voldoen nie, is dit moontlik dat hy dalk nie slaag nie en gevolglik nie die B.Sc.-bosbougraad toegeken word nie!

As doktersgrade onder omstandighede, soos hierbo vermeld, verwerf kan word, ontstaan die vraag of ons Suid-Afrikaanse studente werklik so skrander is om sulke geniale tesisse oor bosboukundige onderwerpe te lewer dat die betrokke oorsese Inrigtings geen akademiese kwalifikasies in die basisvakke van die bosbouwetenskap vereis nie. Of word miskien eredoktersgrade vir verdienstelike prestasies tot bevordering van die bosbouwetenskap (waarvan ons maar nog net nie weet nie) toegeken?

Dit is opmerklik dat dergelyke doktersgrade veral aan 'n sekere oorsese universiteit verkry kan word, en dit is met groot teleurstelling dat kennis geneem word van die feit dat die studie in die bosbouwetenskap aan dié betrokke Inrigting so „goedkoop" geword het, omdat dit tot die oudste Bosbou-akademië behoort, en nog altyd baie hoog aangeskrewe gestaan het. (Hiermee wil natuurlik geen afbreuk gedoen word aan 'n doktersgraad wat op akademiese grondslag geskoei is en aan dieselfde Inrigting verwerf is nie).

Die vraag is nou of diegen wat aan die prestige van die bosbouprofessie in Suid-Afrika help bou, genoë moet neem met die verkleinering van die Wetenskap, wat die basis van hul professie vorm? As hierdie prestige opgebou moet word inplaas van om afgebreek te word, dan moet sulke goedkoop doktersgrade seer sekerlik nie in hierdie land erken word nie—altans nie deur die Suid-Afrikaanse bosbouvereniging nie.

Die menings van verskeie lede wat by hierdie saak belang het is reeds ingewin, maar graag sou opmerkings van ander lede ook verneem word.

Die Uwe,

D. R. DE WET.

Aan die REDAKTEUR.

Meneer,

Bostaande brief van Ir. de Wet is aan my getoon voor die ter perse gaan van u tydskrif.

Die aantygings wat daarin gemaak word geld, soos die skrywer tot 'n mate te kenne gee, slegs vir een sekere oorsese universiteit. Ek meen egter dat dit nodig is om op meer oortuigende wyse die feit onder u aandag te bring, dat bogenoemde gevalle as uitsonderings beskou moet word omdat so iets seer seker nie by ander Inrigtings sal voorkom nie.

Laat my toe om as voorbeeld kortliks die vereistes aan te stip wat deur 'n sekere Europese Universiteit aan Suid-Afrikaanse studente wat die B.Sc. (Bosbou)-graad te Stellenbosch verwerf het en daar wil promoveer, gestel word:

1. Die B.Sc. (Bosbou) sertifikaat, sowel as alle ander bewyse van studies wat na verkryging daarvan onderneem is, moet aan die Universiteitsowerhede voorgelê word, alvorens 'n student hom kan laat inskrywe teneinde vir die doktersgraad te werk.

2. Gedurende die studie aldaar moet in minstens 4 basisvakke van die bosbouwetenskap sowel as in ekonomie vir minstens 'n periode van 1 of 2 semesters lesings bygewoon word en die betrokke Professore moet aan die Universiteitsowerhede 'n bevestiging lewer dat klasse werklik bygewoon is.

3. Selfs al sou 'n student na 'n periode van 4 jaar die B.Sc.-graad in bosbou verwerf het en dan vir 2 semesters aan 'n oorsese universiteit in die bosbouwetenskap studeer het, is dit nodig, as hy binne 'n tydperk van 4 semesters (d.w.s. na 'n studietyd van 7 akademiese jare) aan die Universiteit wil Promoveer, dat hy eers toestemming hiertoe by die owerhede moet verkry.

4. Voor so'n Promosie kan plaasvind, moet 'n versoekskrif, vergesel van die B.Sc.-sertifikaat en die nodige besonderhede, aan die Ministerie van Onderwys gerig word om goedkeuring daarvoor te verkry. Nadat hierdie goedkeuring ontvang is en die Promotor saam met 4 ander Professore die tesis gelees en goedgekeur het, moet 'n mondelinge eksamen in elk van die 5 bogenoemde vakke voor die betrokke Professore afgelê word. Indien 'n student nie genoegsame kennis van een van die vakke besit nie, word die doktersgraad, selfs al is die tesis goedgekeur, nie toegeken nie.

Ek hoop dat na aanleiding van hierdie uiteensetting dit duidelik blyk dat geen „eredoktersgrade" uitgereik word aan daardie Universiteit nie en daarmee 'n bewys gelewer is, dat daar weldeeglik oorsese inrigtings is wat die prestige van die bosbouwetenskap op 'n hoë peil bly handhaaf en die uitsonderings deur Ir. de Wet beskrywe, nie die norm verteenwoordig nie.

Die uwe,

HARTWIG.

RESENSIES—REVIEWS

WOOD PRESERVATION. By *George M. Hunt* and *George A. Garratt.* (New York. McGraw-Hill Book Co., Inc., 1938. Pp. 457. Price 30s. net).

Mr. Hunt is in charge of the Section of Wood Preservation at the Forest Products Laboratory at Madison, U.S.A. He is also an active member of the American Wood Preservers' Association. Professor Garratt is a well known authority on Wood Preservation. On a subject in which there has been considerable development in recent years, the authors are, therefore, particularly well qualified to write, and they have put out an admirable publication which covers comprehensively both the theory and practice of wood preservation. The practical value of the book is considerably enhanced by lists of references at the end of each chapter. Many of these references are to the Proceedings of the American Wood Preservers' Association, and it may be said that these Proceedings form the basis of the treatment of a large part of the technical side of the subject. This is probably the largest and best organised association of its kind in the world and, while its expressions essentially have bearing on American practice, they are nevertheless authoritative and may well be applied to South African conditions.

Striking figures in the introductory chapter reveal that in 1936 the number of wood preservation plants operative in the United States was 200 and their aggregate output 222 million cubic feet of treated wood. A detailed description of the agencies of wood deterioration is followed by sections treating comprehensively of wood preservatives, including a number of proprietary compounds, the preparation of material for treatment, and wood preserving processes. A considerable amount of information is collected into an interesting chapter on factors affecting penetration and absorption, but from the evidence available no clear picture of the mechanism of penetration can be obtained. Later chapters deal with the economic aspect of the subject, the properties of treated wood, and plant and equipment. The concluding chapter assembles the most recent data on the fire-retarding treatment of wood.

A cursory study of the book would indeed be an eye-opener to the layman in this country. An idea would be obtained of the present magnitude of the wood preservation industry in a country like America which early realised the value of the practice, and its scope and usefulness in South Africa would at once be appreciated.

P.J.A.L.

THE EMPIRE FORESTRY JOURNAL. Vol. 18, No. 2, 1939. (The Empire Forestry Association. 7s. 6d.).

Two articles in the current issue of *The Empire Forestry Journal* are concerned with territories whose silvas overlap that of the Union. O. B. Miller in "The Makusi Forests of the Bechuanaland Protectorate"

describes reconnaissance survey operations covering some 3,000 square miles of flat forest-clad terrain in the North Eastern portion of the protectorate. In such country triangulation is impracticable, and the job accordingly resolved itself into an extensive series of bush traverses taking eighteen months to complete. The author's experience in controlling this vast undertaking has enabled him to present a brief but very vivid description of the terrain, its forest growth, its inhabitants, and its fauna. Observations on the forest growth are recorded with an ecological flair which is thrown into relief by the very simplicity with which his conceptions are expressed. The following passage characteristically illustrates his attitude :—

> Musheshe (*Burkea africana*) is found wherever the loose sand sheet has become too shallow for the requirements of Mukusi. This is not to say that it is not to be found occasionally in the Mukusi association, for, like *Terminalia*, it will come in on badly burnt forest, but where it occupies large areas, pure or with Mukwa, it is on partially denuded lines of drainage. Here possibly, on the more compacted dark grey sand, soil acidity prevents the advance of any other tree species. Again, the floor of Musheshe forest, whether of Burkea only or of Burkea-Pterocarpus, is usually heavily grassed, and the two last-mentioned species are amongst the most fire-resistant of trees.

The other article of South African interest is C. E. Duff's "Timber for Copper Mines." The author discusses the timber and firewood requirements of the Northern Rhodesian Copper Belt, and the persistance of conveniently situated local supplies. Timbering requirements, owing to the hard nature of the country rock, and to a technique that relies largely on lode pillars for support, are surprisingly small. Timber on the copper mines is, however, put to strange uses. The refineries for instance, we are told, use thousands of heavy tree trunks annually for plunging into the molten copper to purify it, "as a swizzle stick removes the bubbles from a whisky and soda." To satisfy all requirements the author estimates that the Belt requires some 500 square miles of its best tracts of *Brachystegia* and *Isoberlinia* woodlands to be maintained permanently under forest management.

The two genera mentioned fortunately coppice profusely, otherwise the difficulties of management discussed by the author would be greatly aggravated. To begin with, the life of the ore bodies is very uncertain. It has been estimated at anything between 50 and 100 years. Localisation of future development is impossible to forecast, and demand, both in total volume and in specification is, in the nature of the industry, capricious. Costliness of transport again restricts economical exploitation to a very short radius. "Bwana Makuba, the biggest copper mine ten years ago, is now abandoned altogether, and three million pounds' worth of plant and buildings lie lost amongst the re-invading bush. How fortunate," continues the author, "that no time and money were spent there on 'forestry' !"

In order to meet sudden changes in specification the author, assuming that stabilisation of the industry will be accompanied by standardisation of timber requirements, suggests the preparation of separate working circles for each of the main classes consumed. The assumption, to our mind, seems to place the onus of cure more on the

mines than on the organiser of forest resources. The bugbear of fluctuating consumption, he suggests, might be mitigated by—

(i) preparing especially good stock maps which would assist one to allocate excessive fellings of, say, 8-inch poles, during a prolonged boom with the least harmful effect; and

(ii) keeping certain well-stocked areas, especially of mature sizes, in reserve against special emergencies.

The prospect of any alternative market for the Copper Belt woodlands, in his opinion, simply does not exist.

In an interesting historical sketch of "State Forestry in Tasmania" it is pleasing to encounter this tribute to the late Sir David Hutchins, to whose efforts in the sphere of forestry South Africa is so deeply indebted:—

> .....There is little doubt that the awakening in public and governmental interest in forestry was in no small measure due to two outstanding personalities, namely Sir D. E. Hutchins and the late Lord Novar.....Hutchins was a forester of international repute, who visited Tasmania in 1914, and the strictures contained in his report were calculated to galvanise the most apathetic Government to action.

A number of articles of more general interest, and the usual generous quota of authoritative reviews, contribute still further in maintaining the consistently high standard of the Journal.

The

Journal of the South African Forestry Association

October

PUBLISHED BY THE ASSOCIATION
April and October

Die

Tydskrif van die Suid-Afrikaanse Bosbouvereniging

Oktober

UITGEGEE DEUR DIE VERENIGING
April en Oktober

No. 5. *1940*
PRETORIA
6/-

SOUTH AFRICAN FORESTRY ASSOCIATION

Patron:

HIS EXCELLENCY THE GOVERNOR-GENERAL,
THE RIGHT HON. SIR PATRICK DUNCAN, G.C.M.G., K.C.

President:

COLONEL THE HONOURABLE DENEYS REITZ, M.P.

Vice-Presidents:

COLONEL THE HONOURABLE W. R. COLLINS, M.P., D.T.D., D.S.O.
HANS MERENSKY, DR.ING.H.C., D.SC.
H. J. VAN DER BIJL, PH.D., D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.
P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.
C. E. LEGAT, C.B.E., B.SC.

OFFICERS:

Chairman: J. D. KEET, DIP.FOR., M.SC. (HON.)
Vice-Chairman: H. A. READ, F.S.A.A.
Hon. Editor: J. M. TURNBULL, DIP.FOR.
Hon. Secretary-Treasurer: I. J. CRAIB, M.F., PH.D.

Executive Committee:

J. D. KEET, DIP.FOR., M.SC. (HON.), (*Chairman*)
H. A. READ, F.S.A.A. (*Vice-Chairman*)
H. A. LORENTZ, LL.D.
PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.
W. E. WATT, A.F.C., B.A., DIP.FOR.
J. M. TURNBULL, DIP.FOR. (*Editor*)
I. J. CRAIB, M.F., PH.D. (*Sec.-Treas.*)

ANNUAL REPORT FOR THE YEAR ENDED MAY 31st, 1940.

Satisfactory progress was made by the Association during the past year. The Association was honoured by having Mr. Legat accept the office of Vice-President.

The office of Chairman was held by Mr. J. D. Keet. In terms of Article V, Section 3, of the Constitution, Mr. W. E. Watt and Dr. I. J. Craib were appointed by the Executive Committee to fill the vacancies caused by the resignations of Mr. C. O'C. Maggs (Committee Member) and Mr. E. K. Marsh (Hon. Secretary-Treasurer) respectively, both of whom are now on active military service.

The membership of the Association at the close of the year was as follows :—

Life Members	6	
Full Members	161	
Associate Members ...	142	
Affiliated Members ...	50	(having 58 nominees)
Honorary Officers and Members	7	
Total	374	

Seventy-seven new members were enrolled by the Association and 24 members resigned, resulting in a net increase of 53 members. All members are again urged to bring the objects of the Association to the notice of their friends interested in these objects, and to endeavour to enrol them as members. The fortunes of the Association during the current abnormal circumstances will directly depend upon the financial support provided through the annual subscriptions of members; the interests of forestry in the Union would receive a severe set-back were the activities of the Association now to be unduly curtailed or suspended through lack of adequate financial support.

The accounts submitted with this report show that the income for the year was £626 19s. 9d. and the expenditure £501 1s. 3d., leaving an excess of income over expenditure of £125 18s. 4d. If to this is added the surplus of £23 5s. 6d. for the previous year, it will be seen that the Association has a balance of £149 3s. 10d. in hand, of which £115 was received in the form of donations.

Two numbers of the Journal were published during the year and continued to receive favourable notices both at home and overseas. The sizes of both these issues exceeded those for the previous year.

The Association is much indebted to its Executive Committee and its Editorial Committee for their able and willing assistance during the past year, but our thanks are due particlularly to the Hon. Secretary-Treasurer, Mr. E. K. Marsh, who bore the brunt of the administration of the Association's activities, and to the Editor, Mr. J. M. Turnbull, who so ably maintained the high standard set in the Journal during the first year. We have also to thank those who submitted contributions to the Journal and those of our members who have been active in securing new members.

Mr. A. N. White consented to act as Honorary Auditor and his services are gratefully acknowledged.

(Sgd.) J. D. KEET,
Chairman.
19th August, 1940.

SECOND ANNUAL GENERAL MEETING.

HELD AT SOMERSET HOUSE, VERMEULEN STREET, PRETORIA, AT 8.30 P.M. ON AUGUST 19, 1940.

Attendance : Eleven members were present.

1. Mr. Watt, seconded by Ir. de Wet, proposed that the notice convening the meeting be taken as read. The proposal was carried unanimously.
2. The Chairman then welcomed those present and offered the apologies of Mr. Read, Vice-Chairman of the Association, for his inability to attend. He specially welcomed Dr. Lorentz, who had recently been elected unopposed to the vacant office on the Executive, Mr. Eckbo, who had been unable to attend the First Annual General Meeting of the

Association, and Professor Neethling from Stellenbosch. He congratulated Mr. Turnbull on the high standard he had maintained in the Journal and thanked the Executive and Editorial Committees for the able and willing assistance which they had rendered to him as Chairman during the past year.

3. Professor Neethling, who had recently visited Dr. Merensky at Duivelskloof, then conveyed to the meeting the latter's best wishes for the success of the meeting and the progress of the Association generally.

4. The Chairman referred to the poor demand from members for the publicity stamps of the Association advertised in the third issue of the Journal, and notified the meeting of the Executive Committee's decision to issue these stamps *gratis* to members in future. Mr. Keet drew attention to the generous donation presented to the Association by the Chamber of Mines and Mr. Connell Maggs. He gave a short resume of the progress made during the last Parliamentary Session upon the Veld and Forest Conservation Bill, and commented upon the encouraging response received from the public in its support. The Bill aims at a strengthening of the laws relating to our forest resources and seeks to give to privately-owned forests the status now possessed only by State-owned forest reserves.

Mr. Keet referred to the conspicuous success of the exhibit of wild flowers staged by the Division of Forestry at the Caledon Show, and hoped that this policy would be maintained. It is proposed, henceforth, to stage similar exhibits at Caledon and Ceres in alternate years. These exhibits do much to bring to the notice of the public the conservation of indigenous flora which is one of the Division's main functions on its extensive reserves.

The Chairman also drew attention to the significant contribution which timber, grown in South Africa, had made to the maintenance of local industry since the declaration of war. Very large parcels of timber were being marketed from State plantations and will be available in still greater quantities as soon as adequate milling facilities are available to permit of increased output by existing enterprises. No overcutting of wood increment, justifiable during a period of national emergency, had, as yet, taken place in South Africa. He referred to and deplored the steep rise in the price of timber imported from overseas, as this merely encouraged the use of substitutes. Prior to the war the local saw-milling business was not economically sound as it had to compete with imported timber subsidised by foreign governments. He hoped that the reasonable profits now being made by millers in the home industry would enable them to stabilize this new industry on a permanent basis and to redeem a part, at least, of the inflated capital cost of machinery imported since the declaration of war. Mr. Keet referred to complaints by consumers of local wood products, particularly agricultural and industrial boxes, regarding the rise in price. If these continued, Mr. Keet stated that he thought the only solution would be control of prices by the Government; such action would not benefit consumers for it would merely tend to raise the prices of local products until they were in conformity with those of similar imported products. Consumers of locally-manufactured boxes were not justified in complaining about the rise in price in view of the fact that their competitors were paying appreciably more for similar imported articles.

5. In view of the publication of the minutes of First Annual General Meeting of the Association in the third issue of the Journal, Mr. Turnbull, seconded by Mr. Eckbo, proposed that these minutes be taken as read. The proposal was carried unanimously. In the absence of any amendments these minutes were confirmed by the meeting and approved by the Chairman.

6. The Hon. Secretary-Treasurer then read the Annual Report of the Association and presented the balance sheet for the past year.

7. The Editor of the Journal informed the meeting that a considerable amount of copy was available for publication. He anticipated no difficulty in securing a sufficient number of suitable articles to comprise the two issues, more or less normal in size, for the current year.

8. A general discussion on ways and means by which the membership of the Association could be increased, followed. All members attending the meeting spoke. Numerous speakers felt that the objects of the Association were not sufficiently known to the general public, and that the Journal was too technical to hold the interest of lay members of the Association. The difficulty of securing popular articles, suitable for publication, was referred to. Most of the contributors to the Journal are professional officers who, because of their training, find it almost impossible to prepare articles of the type required. One speaker drew particular attention to the danger of lowering the existing prestige of the Journal in professional quarters, were it made so popular as to make little or no contribution to the science of forestry.

The meeting was unanimous, however, in its opinion that more could be done to interest a wider cross-section of readers by securing a better balance between technical and popular articles in the Journal. Furthermore, numerous practical suggestions were made whereby the activities of the Association could be more widely advertised. Amongst these were the sponsoring by the Association of wild flower shows; handbills, membership forms and placards at Agricultural shows; regional committees to decentralize the activities of the Association; lectures; field days and excursions; the publication in the Journal of articles of general interest such as articles on birds, game, termite control and soil erosion.

After considerable discussion Dr. Lorentz, seconded by Mr. Watt, proposed the following resolution which the meeting passed unanimously:

That the Executive Committee, if feasible,

(a) establish regional committees of the Association in various centres of the Union with a view to giving effect to the objects of the Association through, for example, the holding of meetings or excursions.

(b) obtain more articles in which sound technical practice is presented in a more popular manner than heretofore.

(c) give greater prominence to the activities of the Association at agricultural shows and exhibits.

9. Dr. Craib, seconded by Mr. O'Connor, proposed a vote of thanks to Messrs. Marsh, Maggs and de Wet, who had recently either resigned or retired from the Executive Committee, for the services they had rendered the Association. The proposal was carried unanimously.

10. Mr. Eckbo, seconded by Professor Neethling, proposed a vote of thanks to the Chairman. The proposal was carried unanimously.

11. Ir. de Wet seconded by Mr. Voorendyk, proposed a vote of thanks to Mr. A. N. White, the Honorary Auditor of the Association. The proposal was carried unanimously.

12. Mr. Watt, seconded by Dr. Craib, proposed a special vote of thanks to Messrs. Maggs Investments Ltd. for the use of the Council Chamber at Somerset House on this occasion, and for the assistance given in providing refreshments after the meeting. The proposal was carried with acclamation.

The meeting closed at 11 p.m.

(Sgd.) IAN CRAIB,
Hon. Secretary-Treasurer.
19th July, 1940.

INCOME AND EXPENDITURE ACCOUNT

EXPENDITURE.

To Publication of Journal	£241 19 9		
Add amount outstanding	157 6 2		
	£399 5 11		
Less amount due in 1938/39	5 16 11		
	£393 9 0		
Add amount paid in 1938/39	14 1 6	£407	10 6
To Printing of Reprints		55	12 6
To Stationery and Office Sundries		15	0 7
To Postage Stamps		8	2 5
To Printing Publicity Stamps		5	6 0
To Bank Commission and Discount on Bills		5	14 5
To Bank Charges		1	2 6
To Miscellaneous Expenses		2	6 6
To Refund of Overpayments of Subscriptions		0	6 0
To Balance (Surplus of Income over Expenditure for 1939/40)		125	18 4
		£626	19 9

BALANCE SHEET AS

LIABILITIES.

Subscriptions paid in Advance—			
Life Members	£82 19 0		
Other Members	8 0 0		
To Journal	2 3 6	£93	2 6
Sundry Creditors		157	6 2
Capital Account—			
Surplus for 1938/39	£23 5 6		
Surplus for 1939/40	125 18 4	149	3 10
		£399	12 6

I hereby certify that I have examined the books and accounts of the account and Balance Sheet are a true and correct statement of the Association's

FORESTRY ASSOCIATION

FOR THE YEAR ENDED 31st MAY, 1940.

INCOME.

By Subscriptions—			
Life Members			£6 6 0
Other Members	£284 17 6		
Add Payments in Advance 1938/39	5 17 6		
	£290 15 0		
Less Payments in Arrear 1938/39	3 12 0		
	£287 3 0		
Add Payments in Arrear 1939/40	1 8 6		
	£288 11 6		
Less Payments in Advance 1939/40	5 0 0		283 11 6
By Sale of Journals	£61 11 0		
Less Payments in Advance	2 3 6		
	£59 7 6		
Add Amount Outstanding	41 14 6		101 2 0
By Sale of Reprints	£47 7 1		
Add Amount Outstanding	39 8 3		86 15 4
By Advertisements	£30 19 0		
Add Amount Outstanding	18 19 10		
	£49 18 10		
Less Amount due in 1938/39	18 9 6		31 9 4
By Donations			115 0 0
By Commission on Cheques			2 1 9
By Sale of Publicity Stamps			0 7 10
By Overpayments of Subscriptions			0 6 0
			£626 19 9

AT 31st MAY, 1940

ASSETS.

Cash in Bank	£298 1 5
Sundry Debtors	100 2 7
Subscriptions in Arrears	1 8 6
	£399 12 6

South African Forestry Association and that the above Income and Expenditure position.

(Sgd.) A. N. WHITE.

SUID-AFRIKAANSE BOSBOUVERENIGING

Beskermheer :

SY EKSELLENSIE DIE GOEWERNEUR-GENERAAL,
DIE HOOGEDELAGBARE SIR PATRICK DUNCAN,
G.C.M.G., K.C.

President :

DIE EDELAGBARE KOLONEL DENEYS REITZ, L.V.

Vise-Presidente :

DIE EDELAGBARE KOLONEL W. R. COLLINS, L.V., D.T.D., D.S.O.
HANS MERENSKY, DR.ING.H.C., D.SC.
H. J. VAN DER BIJL, D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.
P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.
C. E. LEGAT, C.B.E., B.SC.

AMPSDRAERS :

Voorsitter : J. D. KEET, DIP.FOR., M.SC. (ERE.)
Vise-Voorsitter : H. A. READ, F.S.A.A.
Ere-Redakteur : J. M. TURNBULL, DIP.FOR.
Ere-Sekretaris-Tesourier : I. J. CRAIB, M.F., PH.D.

Uitvoerende Komitee :

J. D. KEET, DIP.FOR., M.SC. (ERE.), (*Voorsitter*)
H. A. READ, F.S.A.A. (*Vise-Voorsitter*)
H. A. LORENTZ, LL.D.
PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.
W. E. WATT, A.F.C., B.A., DIP.FOR.
J. M. TURNBULL, DIP.FOR. (*Ere-Redakteur*)
I. J. CRAIB, M.F., PH.D. (*Ere-Sec.-Tes.*)

JAARVERSLAG VIR DIE JAAR GEËINDIG OP 31ste MEI, 1940.

Die Vereniging het gedurende die afgelope jaar bevredigende vordering gemaak.

Mnr. Legat het die Vereniging vereer deur die amp van Vise-President te aanvaar.

Mnr. J. D. Keet het as voorsitter opgetree.

Ooreenkomstig Afdeling V, Artikel 3, van die Konstitusie is mnr. W. E. Watt en dr. I. J. Craib deur die Uitvoerende Komitee aangestel om die vakante poste, wat veroorsaak is deurdat mnr. C. O'C Maggs (Komitee-lid) en mnr. E. K. Marsh (Ere Sekretaris-Tesourier) bedank het, te vul; laasgenoemde is tans altwee op aktiewe militêre diens.

Die ledetal van die Vereniging was aan die end van die jaar as volg :—

Lewenslange lede	6	
Volle lede	161	
Geassosiëerde lede	142	
Geaffiliëerde lede	50	(met 58 benoemde lede)
Ere ampsdraers en lede ...	7	
Totaal	374	

Sewe-en-sewentig nuwe lede is by die Vereniging ingeskryf en 24 lede het bedank, met die gevolg dat die ledetal met 53 toegeneem het. Alle lede word dringend versoek om die doel en strewe van die Vereniging onder die aandag van hul vriende, wat daarin mag belangstel, te bring en om hulle as lede te probeer werf. Die fondse van die Vereniging sal gedurende die huidige abnormale omstandighede direk afhanklik wees van die finansieële ondersteuning wat dit deur jaarlikse subskripsies van sy lede sal verkry; bosbou-belange in die Unie sal 'n ernstige terugslag kry as die werksaamhede van die Vereniging nou, as gevolg van 'n gebrek aan finansiële ondersteuning, meer as wat nodig is, ingekort of gestaak moet word.

Die balansstaat wat saam met hierdie verslag ingedien word, toon aan dat die inkomste vir die jaar £626 19s. 9d. bedra het; die uitgawe was £501 1s. 1d., sodat die inkomste £125 18s. 4d. meer as die uitgawe gewees het. Indien die oorskot van £23 5s. 6d. van die vorige jaar hierby gevoeg word, sal opgemerk word dat die Vereniging 'n balans van £149 3s. 10d. in die bank het. Hiervan is £115 as skenkings ontvang.

Gedurende die jaar is twee uitgawes van die tydskrif gepubliseer en daar is weer beide plaaslik en oorsee baie gunstig oor opgemerk. Die grootte van beide hierdie uitgawes het dié van die vorige jaar oortref.

Die Vereniging is veel verskuldig aan sy Uitvoerende Komitee en sy Redaksie Komitee vir hul welwillende en bekwame medewerking gedurende die afgelope jaar, maar ons is veral dank verskuldig aan Mnr. E. K. Marsh die Ere Sekretaris-Tesourier, wie die laste van die Vereniging se administrasiewerk gedra het en ook aan mnr. J. M. Turnbull, die Editeur, wie op 'n bekwame wyse daarin geslaag het om die hoë standaard wat gedurende die eerste jaar gestel is, te handhaaf. Ons moet ook diegene bedank wat bydraes vir die tydskrif gelewer het, asook die lede wat daarin geslaag het om nuwe lede te werf.

Mnr. A. N. White het toegestaan om as Ere-Ouditeur op te tree, en sy dienste word met dank erken.

(Get.) J. D. KEET,
Voorsitter.
19 Augustus, 1940.

TWEEDE JAARLIKSE ALGEMENE VERGADERING.

OM 8.30 N.M. OP 19 AUGUSTUS 1940, TE SOMERSET HOUSE, VERMEULENSTRAAT, PRETORIA, GEHOU.

Opkoms : Daar was elf lede teenwoordig.

1. Mnr. Watt het voorgestel dat die kennisgewing waarvolgens die vergadering byeen geroep is as gelees aangeneem moet word; Ir. de Wet het gesekondeer en die voorstel is algemeen aangeneem.
2. Die Voorsitter het die persone wat teenwoordig was welkom geheet en 'n verontskuldiging van mnr. Read, Vise-Voorsitter van die Vereniging, aangebied omdat hy nie aanwesig kon wees nie. Hy het

'n besondere woord van verwelkoming aan dr. Lorentz, wie onlangs as Uitvoerende Komiteelid gekies is, mnr. Eckbo, wie die eerste jaarlikse algemene vergadering nie kon bywoon nie, en professor Neethling van Stellenbosch, gerig. Hy het mnr. Turnbull gelukgewens met die hoë standaard van die tydskrif wat hy gehandhaaf het en het ook die Uitvoerende en Redaksie Komitees bedank vir die welwillende hulp en bystand wat hulle aan hom as Voorsitter gedurende die afgelope jaar verleen het.

3. Professor Neethling wie onlangs by dr. Merensky te Duiwelskloof op besoek was het toe aan die vergadering laasgenoemde se beste wense vir die welslae van die vergadering en die vooruitgang van die Vereniging in die algemeen, oorgedra.

4. Die Voorsitter het na die geringe aanvraag deur lede vir publisiteitseëls van die Vereniging, wat in die derde uitgawe van die tydskrif geadverteer is, verwys en aan die vergadering meegedeel dat die Uitvoerende Komitee besluit het om hierdie seëls in die toekoms aan lede gratis uit te gee. Mnr. Keet het ook na die milde skenkings aan die Vereniging, deur die Kamr van Mynwese en mnr. Connell Maggs, verwys. Hy het 'n kort oorsig gegee van die vordering wat gedurende die laaste Volksraadsitting in verband met die Bos- en Veldbewarings Wetsontwerp gemaak is en het gewys op die bemoedigende antwoorde wat van die publiek in ondersteuning daarvan, ontvang is. Die Wetsontwerp streef daarna om die wette in verband met ons bosbou besittings te versterk en om aan privaat bosse dieselfde status te gee as wat tans slegs deur Staatsbosreserwes beklee word.

Mnr. Keet het na die uitstaande sukses wat die uitstalling van veldblomme deur die Afdeling Bosbou op die Caledon tentoonstelling tebeurt geval het, verwys en die hoop uitgespreek dat hierdie beleid gehandhaaf sal word. Die voorneme is om dergelyke uitstallings voorstaan afwisselend te Caledon en Ceres al om die ander jaar te hou. Hierdie uitstallings dra baie by om een van die vernaamste funksies van die Afdeling, naamlik, die beskerming van inheemse plantegroei op sy uitgestrekte reserwes, onder die aandag van die publiek te bring.

Die Voorsitter het ook gewys op die betekenisvolle bydrae van die Suid-Afrikaans gekweekte hout om die plaaslike nywerheid, nadat oorlog verklaar is, in stand te hou. Baie groot hoeveelhede saaghout uit Staatsplantasies is bemark en nog groter hoeveelhede sal beskikbaar wees sodra geskikte saagmeulgeriewe verkry kan word en bestaande ondernemings daardeur instaat gestel word om hul produksie te verhoog. Meer as die houtaanwas, wat gedurende 'n tyd van nood in die land geregverdig sou wees, word nog nie in Suid-Afrika gekap nie. Hy het na die skerp styging in die pryse van ingevoerde hout van oorsee verwys en dit betreur omdat dit die gebruik van surrogate aanmoedig. Voor die oorlog was die saagmeul-besigheid ekonomies nie sterk nie, daar dit met geimporteerde hout wat buitelandse regerings gesubsidiëer het, moes wedywer. Hy vertrou egter dat die redelike profyte wat deur saagmeuleienaars van die plaaslike nywerheid nou gemaak word hulle instaat sal stel om hierdie nuwe nywerheid op 'n blywende grondslag te vestig en om tenminste 'n gedeelte van die verhoogde kapitaalkoste van masjinerie, wat na die verklaring van oorlog ingevoer is, terug te kry. Mnr. Keet het besware in verband met prysstygings, deur plaaslike verbruikers van houtprodukte, veral landbou- en industriëele kassies, aangehaal en gesê dat as dit voortduur hy van mening is die enigste oplossing sal wees as die regering die pryse kontroleer. So'n stap sal nie in die voordeel van die verbruikers wees nie, omdat dit slegs daartoe sal lei dat die pryse van plaaslike produkte sal styg, totdat dit met dié van dergelyke geimporteerde produkte gelyk is. Die klagtes van verbruikers van plaaslik vervaardigde kassies oor die styging in pryse daarvan, is nie geregverdig nie, omdat hul mededingers vir dergelyke geimporteerde artikels aansienlik meer moet betaal.

5. Aangesien die notule van die eerste jaarlikse algemene vergadering van die Vereniging in die derde uitgawe van die tydskrif gepubliseer is, het mnr. Turnbull voorgestel dat die notule as gelees aangeneem moet word; mnr. Eckbo het gesekondeer en die voorstel is algemeen aangeneem. Die notule is sonder wysigings deur die vergadering aangeneem

en deur die Voorsitter goedgekeur.

6. Die Ere Sekretaris-Tesourier het toe die jaarverslag van die vereniging gelees en die balansstaat vir die afgelope jaar voorgelê.

7. Die Editeur van die tydskrif het die vergadering meegedeel dat 'n aansienlike aantal artikels vir publikasie beskikbaar is. Hy verwag nie dat daar moeilikheid sal wees om 'n voldoende aantal geskikte bydraes te kry om twee uitgawes, min of meer van normale grootte, vir die lopende jaar saam te stel nie.

8. 'n Algemene bespreking oor die moontlikhede hoe die ledetal van die vereniging vergroot kan word het hierop gevolg en alle aanwesige lede het gepraat. Baie sprekers het gevoel dat die doel en strewe van die vereniging nie by die algemene publiek voldoende bekend is nie en dat die tydskrif te tegnies is om die belangstelling van die leeklede van die Vereniging te behou. Daar is verwys na die moeilikheid om populêre artikels, wat vir publikasie geskik is, te verkry. Die meeste persone wat bydraes vir die tydskrif stuur is professionele beamptes en uit die aard van hul opleiding is dit vir hulle byna onmoontlik om artikels van die gewenste gehalte te skryf. Een spreker het veral gewys op die gevare verbonde aan die vermindering van die prestige wat die tydskrif reeds in professionele kringe verwerf het, veral as dit so populêr gemaak word dat dit weinig of niks tot die bosbouwetenskap bydra nie.

Die vergadering was egter eenparig van mening dat meer gedoen kan word om belangstelling by 'n groter leserskring op te wek, deur 'n beter verhouding tussen tegniese en populêre artiekels in die tydskrif te bewerkstellig. Ook is talryke praktiese voorstelle gemaak om die werksaamhede van die Vereniging wyd en syd te adverteer. Onder andere word voorgestel dat die Vereniging veldblommetentoonstellings kragtig moet ondersteun; strooibiljette, lidmaatskapvorms en plakkate by tentoonstellings; streek-komitees om die werksaamhede van die Vereniging te desentraliseer; bosboudae en -uitstappies; in die tydskrif moet artikels van algemene belang, byvoorbeeld oor voëls, wild, termietkontrole en gronderosie opgeneem word.

Na 'n lang bespreking het dr. Lorentz die volgende voorstel, wat deur mnr. Watt gesekondeer en algemeen aangeneem is, gemaak :—

Dat die Uitvoerende Komitee, indien moontlik,

(a) streek-komitees van die Vereniging in verskeie dele van die Unie stig om aan die doel en wese van die Vereniging gevolg te gee deur byvoorbeeld vergaderings en uitstappies te organiseer.

(b) meer artiekels verkry waarin tegniese ondervinding in 'n meer populêre wyse voorgedra word as wat tot dusver die geval was.

(c) die werksaamhede van die Vereniging met landbouentoonstellings en uitstallings meer op die voorgrond bring.

9. Dr. Craib het 'n mosie van dank aan mnre. Marsh, Maggs en de Wet wie onlangs as lede van die Uitvoerende Komitee òf bedank òf afgetree het, voorgestel vir die dienste wat hulle aan die Vereniging gelewer het. Mnr. O'Connor het gesekondeer en die voorstel is algemeen aangeneem.

10. Mnr. Eckbo het 'n mosie van dank aan die Voorsitter voorgestel. Professor Neethling het gesekondeer en die voorstel is algemeen aangeneem.

11. Ir. de Wet het 'n mosie van dank aan mnr. A. N. White, die Ere Ouditeur, voorgestel. Mnr. Voorendyk het gesekondeer en die voorstel is algemeen aangeneem.

12. Mnr. Watt het 'n mosie van besondere dank aan die Maggs Investments Ltd. voorgestel vir die gebruik van die Raadkamer te Somerset House vir hierdie geleentheid, asook vir die hulp wat verleen is om verversings na afloop van die vergadering te verskaf. Dr. Craib het gesekondeer en die voorstel is met algemene handegeklap aangeneem.

Die vergadering is om 11 n.m. verdaag.

(Get.) IAN CRAIB,
Ere Sekretaris-Tesourier.
19 Julie, 1940.

SUID-AFRIKAANSE

INKOMSTE EN UITGAWE REKENING

UITGAWE.

Vir Publikasie van tydskrif	£241 19 9		
Plus bedrag verskuldig	157 6 2		
	£399 5 11		
Min bedrag uitstaande vir 1938/39	5 16 11		
	£393 9 0		
Plus bedrag betaal 1938/39	14 1 6	£407 10 6	
Herdrukke		55 12 6	
Skryfbehoefte en kantoorbenodighede		15 0 7	
Posseëls		8 2 5	
Druk van publisiteitseëls		5 6 0	
Bankkommissie en diskonto op wissels		5 14 5	
Bankfooie		1 2 6	
Diverse uitgawes		2 6 6	
Terugbetaling van oorbetalings op subskripsies ...		0 6 0	
Balans (Oorskot van Inkomste oor Uitgawe vir 1939/40)		125 18 4	
		£626 19 9	

BALANSSTAAT OP

LASTE.

Subskripsies vooruitbetaal	£82 19 0		
Lewenslange lede	8 0 0		
Ander lede	8 0 0		
Vir tydskrif	2 3 6	93 2 6	
Diverse krediteure		157 6 2	
Kapitaal Rekening—			
Ooorskot 1938/39	£23 5 6		
Oorskot 1939/40	125 18 4	149 3 10	
		£399 12 6	

Ek sertifiseer hiermee dat ek die boeke en rekeninge van die Suid
Rekening en Balansstaat 'n ware en korrekte weergawe van die Vereniging se

BOSBOUVERENIGING

VIR DIE JAAR GEËINDIG 31ste MEI, 1940.

INKOMSTE.

Subskripsies—lewenslange lede		£6 6 0
Ander lede	£284 17 6	
Plus vooruitbetalings 1938/39	5 17 6	
	£290 15 0	
Min agterstallige betalings 1938/39	3 12 0	
	£287 3 0	
Plus agterstallige betalings 1939/40	1 8 6	
	£288 11 6	
Min vooruitbetalings 1939/40	5 0 0	283 11 6
Verkoop van tydskrifte	£61 11 0	
Min vooruitbetalings	2 3 6	
	£59 7 6	
Plus bedrag verskuldig	41 14 6	101 2 0
Verkoop van herdrukke	£47 7 1	
Plus bedrag verskuldig	39 8 3	86 15 4
Advertensies	30 19 0	
Plus bedrag verskuldig	18 19 10	
	£49 18 10	
Min bedrag uitstaande vir 1938/39	18 9 6	31 9 4
Skenkings		115 0 0
Kommissie op tjeks		2 1 9
Verkoop van publisiteitseëls		0 7 10
Oorbetalings op subskripsies		0 6 0
		£626 19 9

31ste MEI, 1940.

BATE.

Kontant in bank	£298 1 5
Diverse skuldenare	100 2 7
Agterstallige subskripsies	1 8 6
	£399 12 6

Afrikaanse Bosbouvereniging nagegaan het en dat bostaande Inkomste en Uitgawe posisie is,

(Get.) A. N. WHITE.

EDITORIAL COMMITTEE.

J. M. TURNBULL, DIP.FOR.—*Chairman.*

I. J. CRAIB, M.F., PH.D.

A. JURRIAANSE, B.SC. (AGRIC.), B.SC. (FY.)

J. D. KEET, M.A. (HON.) (*Ex officio.*)

PROFESSOR E. J. NEETHLING, B.A., M.F.

A. J. O'CONNOR, DIP.FOR.

PROFESSOR JOHN PHILLIPS, D.SC., F.R.S.E., F.L.S.

Contributions on any aspect of forestry or allied subjects will be considered by the Editorial Committee, and should be addressed to the Editor, The Journal of the South African Forestry Association, P.O. Box 727, Pretoria. Articles in excess of 1,000 words should be accompanied by uncopyrighted summaries, not exceeding five per cent. of length of originals. Twelve reprints of each article will be furnished to its author, free. Reprints beyond that number may be obtained, if ordered before the end of the month preceding that of issue, at the following rates per unit of four text pages:—

100	*copies*	£0 16 6
250	,,	£1 5 6
500	,,	£2 0 6
1,000	,,	£3 10 6

Incomplete units will be charged as for complete units. Printed covers ordered at same time as the text will be provided at 21/6 per 100, and 2/- for every 50 in excess thereof. Illustrations extra by arrangement.

Articles will be published in the language in which they are submitted. Summaries may be submitted in either or both official languages.

The Association does not hold itself responsible for statements or views expressed by authors.

Readers are urged to consider the Association's advertisers as occasion may arise.

REDAKSIE-KOMITEE.

J. M. TURNBULL, DIP.FOR.—*Voorsitter.*

I. J. CRAIB, M.F., PH.D.

A. JURRIAANSE, B.SC. (LB.), B.SC. (BSE.)

J. D. KEET, M.A. (ERE.) (*Ex officio.*)

PROFESSOR E. J. NEETHLING, B.A., M.F.

A. J. O'CONNOR, DIP.FOR.

PROFESSOR JOHN PHILLIPS, D.SC., F.R.S.E., F.L.S.

Artikels oor alle aspekte van bosbou sal deur die Redaksie-Komitee in oorweging geneem word, en moet aan die Redakteur, ,,Die Tydskrif van die Suid-Afrikaanse Bosbouvereniging,'' Posbus 727, Pretoria, gerig word. Artikels van meer as 1,000 woorde moet van 'n opsomming van nie meer as vyf persent van die lengte van die artikel self, waarvan kopiereg nie voorbehou is nie, vergesel word. Twaalf herdrukke van elke artikel sal kosteloos aan die skrywer daarvan verskaf word. Mits hulle bestel word voor die einde van die maand voorafgaande die van uitgawe, kan herdrukke bo hierdie hoeveelheid teen die volgende pryse vir eenhede van vier teksblaaie verkry word:—

100 *kopies*	£0	16 6
250 ,,	£1	5 6
500 ,,	£2	0 6
1,000 ,,	£3	10 6

Onvolledige eenhede sal teen dieselfde prys as volledige eenhede gereken word. Gedrukte omslae, bestel gelyktydig met die herdrukke, sal voorsien word teen 21/6 per 100, en 2/- per elke 50 bo die eerste 100. Illustrasies ekstra.

Kontribusies sal gepubliseer word in die taal waarin hulle ingestuur word. Opsommings mag in enige of beide amptelike tale ingedien word.

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of opinies van skrywers nie.

Lesers word versoek om die Vereniging se adverteerders waar gerieflik, in aanmerking te neem.

P. 89, foot.—For 'E. A. CARLSON," read "K. A. CARLSON."

CONTENTS—INHOUD

The Association does not hold itself responsible for statements or views expressed by authors. With the exception of authors' summaries copyright of all articles is reserved.

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of menings wat deur skywers uitgespreek mag word nie. Met uitsondering van skrywers se opsommings, word kopiereg van alle artikels voorbehou.

PAGE

EDITORIAL NOTES AND COMMENTS—VAN DIE REDAKSIE 1

LOCAL TIMBER SUPPLIES AND THE WAR.
THE ASSOCIATION'S PUBLICITY STAMPS.
BIG TREES.
BRIAR PIPES.

BURMA TEAK AND ITS EXTRACTION, *by F. H. Wroughton* ... 5

SOUTH AFRICA'S DEBT TO JOSEPH BURTT DAVY, *by Mary Gunn* 10

OPRIGTING VAN 'N DRAADHEINING TE KOMATIPOORT, *deur H. L. de Geus, B.Sc. (Bsb.)* 12

THE GROWING OF *Populus Deltoides* IN SOUTH AFRICA, *by E. L. Schiemer* 17

AN INTERLOPER FROM BRAZIL, *by M. H. Scott, B.Sc.* ... 29

NOTES ON SOME LANGEBERG FORESTS, *by Thunberg and J. J. Kotze, B.A., B.Sc.* 32

AFRIKAANSE BOSBOOMNAME, *deur C. L. Wicht, B.Sc., B.A., Dr.Ing.* 41

FIBRIL BEHAVIOUR AS DISCLOSED BY SHRINKAGE OBSERVATIONS, *by John M. Turnbull, Dip.For.* 62

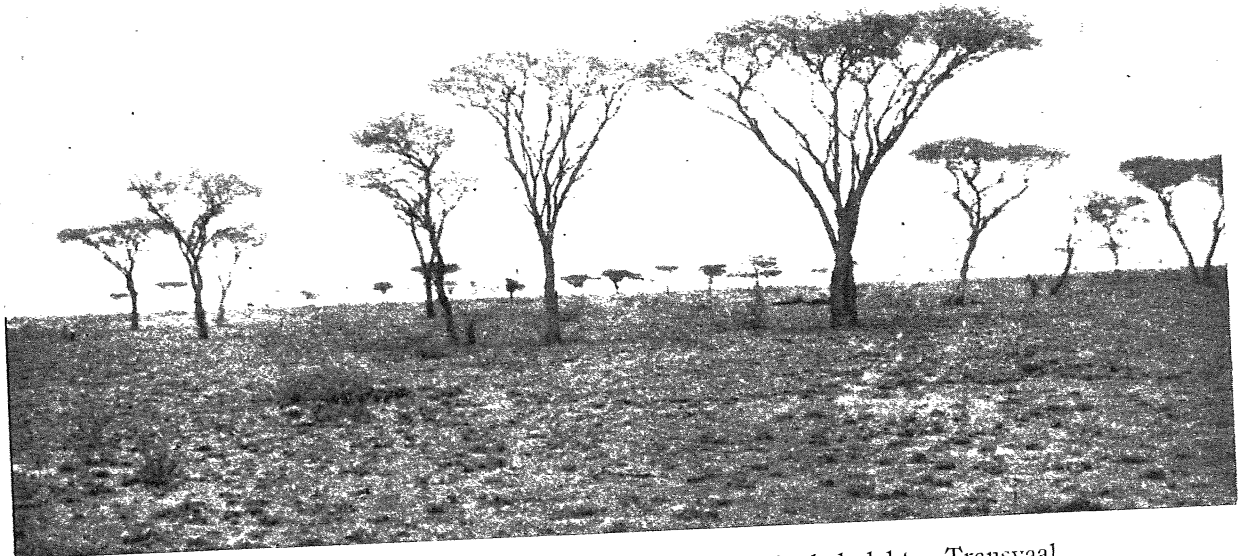
RECLAMATION OF THE CAPE FLATS, *by J. J. Kotze, B.A., B.Sc.* 73

A STANDARD NOMENCLATURE FOR SOUTH AFRICAN GROWN TIMBERS/STANDAARD BENAMINGE VIR HOUTSOORTE IN SUID-AFRIKA GEKWEEK 75

CORRESPONDENCE—KORRESPONDENSIE 81
CULTIVATION OF INDIGENOUS PLANTS.
Eucalyptus Saligna—MINIMISATION OF WASTE.
UNITY AMONGST SALIGNA GROWERS.
A PIONEER EUCALYPT PLANTER.
STATE POLICY REGARDING INDIGENOUS TREES.

REVIEWS—RESENSIES 95
A STUDY OF THE EFFECT OF SWAY ON TREES.
THE VEGETATIVE REPRODUCTION OF FOREST TREES.
HANDBOOK OF STRUCTURAL DESIGN.
AUSTRALIAN FORESTRY. VOL. V., NO. 1.

PUBLICATIONS RECEIVED 100



KAMEELDORINGBOME (*Acacia giraffae*), Springbokvlakte, Transvaal.

THE JOURNAL OF THE
SOUTH AFRICAN FORESTRY ASSOCIATION
No. 5. OCTOBER, 1940.

DIE TYDSKRIF VAN DIE
SUID-AFRIKAANSE BOSBOUVERENIGING
No. 5. OKTOBER, 1940.

EDITORIAL NOTES AND COMMENTS.

VAN DIE REDAKSIE.

Local Timber Supplies and the War.

The Director of Forestry, Mr. J. D. M. Keet, in his capacity of Chairman of our Association, stated at the last annual general meeting that while no overcutting of wood increment has, as yet, taken place in South Africa during the present period of national emergency, such justifiable action would be brought into operation as soon as adequate milling facilities were available. We note this informal statement of government policy with interest and approbation.

The softwood lumber industry in South Africa is young, but it promises to play an important part in local industrial development. Its establishment has been attended by prejudice against the local product, inadequacy of capital investment, shortage of trained milling and manufacturing personnel, and subjection to competition with subsidised dumpings.

Present circumstances are very favourable to its permanent entrenchment. Restriction of timber supplies from the Baltic and the steep rise in price of lumber from other overseas sources have made local industry, particularly in regard to national defence requirements, increasingly dependent on home-grown supplies. The demand for all softwood commodities so greatly exceeds the present output that the wisdom of a national policy of afforestation, initiated half a century ago, is no longer questioned.

There can be no question of our being able to overcut the annual wood increment for the afforested area as a whole. The average plantation is too young for that. On the other hand a thorough reconnaissance of the timber available for sale would doubtless reveal the existence of certain 25 to 50 year old compartments in which a

policy of clearfelling now would be particularly desirable from both the commercial and the technical viewpoint. South African sawmills have hitherto depended almost entirely on relatively small sized thinnings, and there has been little free competition with imported lumber of the larger dimensions. The placing of such lumber on the market now, even in small quantities, will educate consumers regarding the quality of the local product, strengthen the position of the local sawmiller so as to enable him better to withstand a post-war economic dislocation, and appreciably assist the national war effort.

Technical arguments in support of such a policy are no less convincing. There has been an increase in local stumpage values in harmony with the increasing prices of imported timber, and although its persistence, in spite of probable heavy demands to meet post-war reconstruction in Europe, is in no way assured, it will effect a shortening of the financial rotation. Prevailing conditions therefore make for earlier attainment of financial maturity. Clear felling of such stands, justified by better stumpage values, will, moreover, provide opportunity for improved distribution of age class gradations, elimination of poor strains and species, and better adaptation of species to sites when they come to be regenerated. The newly formed stands, again, will enjoy the benefits accruing from the latest developments in management technique. These considerations are all inseparable from the experimental nature of much of the earlier afforestation in the Union. Finally the felling of older timber than has hitherto been available, will yield valuable technical data on the effect of age on wood quality and cost of conversion.

In the application of the policy referred to by Mr. Keet, the Division of Forestry is given an unusual opportunity for consolidating its technical position and enlarging the significant contribution it is already making towards the conduct of the war.

Briar Pipes.

Application to the Timber Development Association of Great Britain for assistance in the search for likely substitutes for the dwindling supplies of root wood of *Erica arborea* for the manufacture of briar pipes, has elicited a suggestion that English yew may fill the bill. According to a writer in the *Timber Trade Journal* of the 17th August, yew possesses many of the properties necessary for pipe making. He points out, moreover, that if proved by trial, this wood has the additional advantage of being native to Britain. In South Africa experiments have been made from time to time with a number of woods, almost invariably stem wood of trees, but none of them seems to have been found wholly satisfactory. Little attention seems to have been paid, in this respect, to the innumerable heath (*Erica*) species of the Cape. It is believed that some fifteen or twenty years ago the suitability of *E. strigosa* was investigated but yielded negative results. This species attains a large size, and it is possibly the small dimensions of other species that has discouraged investigation of the genus. May be aesthetic considerations have discouraged interest. Even were a suitable heath found, however, it should be abundant or readily cultivable. If none such exist possibly other shrub genera might provide suitable root wood. Certain tree roots again, even of species in which stem wood has been

proved useless for the purpose, may yet be found to yield the right material.

THE ASSOCIATION'S PUBLICITY STAMPS.

As will be seen from section 4 of the report of the Association's last annual general meeting, printed in this issue, it has been decided to distribute the publicity stamps, the printing of which was announced at the end of our third issue, to members free. Members should find a pane of ten of these stamps inside their copies of the present issue, and are urged to make use of them. With their colouring they are very effective, and cannot but help arouse the curiosity of recipients of the covers they may decorate, and so make the existence of the Association more widely known.

DIE REKLAMESEËLS VAN DIE VERENIGING.

Soos in artikel 4 van die verslag van die jongste jaarlikse algemene byeenkoms van die Vereniging, wat in hierdie nommer verskyn, opgelet sal word, is dit besluit om die Vereniging se reklameseëls, die druk waarvan op die laaste bladsy van onse 3de nommer aangekondig is, kosvry aan alle lede uit te deel. Tien seëls sal in u kopie van hierdie nommer gevind word, en dit sal hoog op prys gestel word as u hulle op briefkoeverte sal plak. Hierdie kleuryke seëls sal beslis baie doeltreffend gevind word om die bestaan van die Vereniging meer bekend te maak.

BIG TREES.

It is surprising how often the largest specimen of a tree species is claimed to have been discovered. This is largely accounted for by recorders, familiar with a species in a low quality locality, seeing for the first time an average sized individual in an optimum locality. Sometimes it is merely the foible of proud ownership. With its widely distributed membership the Association might do valuable work in accumulating data in this matter, and both members and non-members are invited to report measurements of total height and of girth overbark at breast height (4 ft. 6in. above ground level) of any tree that is seriously thought to be phenomenal in these dimensions. It would be impracticable to record every report, and it is accordingly proposed after accumulation of a reasonable mass of data in respect of individual species to select the most striking measurements for recording in the Journal. Measurements, where possible, should be taken or checked by a professional forest officer or by a land or mine surveyor, and in all cases the name and occupation of the measurer or verifier stated. Before publication of any report steps will be taken to have the botanical identity of the tree concerned verified. Information regarding both indigenous and exotic species will be appreciated. Photographs and herbarium material should not be forwarded until asked for. The following information should as far as possible be furnished in preliminary reports :—

Species
Locality
Date of measurement
Total height in feet
Girth in inches

Condition of tree and remarks on *form* might also be given. In the case of exotic species, *age* can generally be ascertained; but where this cannot be done, and in the case of indigenous species, any circumstance that might conceivably provide a clue should be mentioned.

Once recording of any species in the Journal starts, there should be no further risk of confounding geese and swans so far as it is concerned.

BURMA TEAK AND ITS EXTRACTION

By F. H. WROUGHTON

THERE are few timbers of the world with which the citizen of South Africa comes into more constant contact every hour of the day than Teak and yet few people are aware of the costly and laborious processes which have been involved in its production or that without the assistance of that somewhat slovenly looking aristocrat, the Elephant, there would be no Teak to increase the amenities of this pleasant land.

The reason why Teak is used so generally throughout the Union is firstly because in a climate which is subject to very quick changes from dry to wet the wood expands and contracts to a lesser degree than any other wood in common use throughout the world and secondly because no white ant will touch Teak unless it is in danger of dying from starvation.

The wood has other merits such as its immunity from dry rot, its even texture, its ease of working and its pleasing appearance but, except the experts, few realize that one can put a bolt or nail in teak and the metal remains sound, whereas, with oak, the acid in the wood will eat away the metal in an appreciable time. One can bolt Teak direct on to a girder and neither the metal nor the wood will deteriorate from the contact and for these reasons our railway carriages are universally constructed of Teak, except for internal fittings where more decorative woods are sometimes used, usually in the form of veneers.

If you travel by sea the decks, hand rails, gratings and most of the timber used in the ship will be Teak. Thanks to its low coefficient of expansion we meet it everywhere, as a furniture wood, as doors, windows or frames, as a countertop or a cupboard—anywhere where the usage is hard and we want the joints to "stay put."

Apart from its inherent properties, the method of its production contributes to make Teak a stable wood, for roughly eight years must elapse before the growing tree can reach the saw-mill. The tree grows naturally in limited quantities on the slopes of the Western Ghats of the Indian Peninsula but the production is so limited that it is all consumed locally and so far as the world at large is concerned, Teak (*Tectona grandis*) comes only from a limited territory which is comprised within Burma, Siam and Indo China. It has been introduced as a plantation growth in Java but under those conditions of soil and climate has developed characteristics somewhat differing from those of the naturally grown tree.

So far as woods calling themselves African, Rhodesian or Borneo Teak are concerned, they might equally well have pirated the name oak, for they are in no way related to *Tectona Grandis*.

Teak is a Royal wood, which implies that if you happened to have a Teak tree growing in your own garden, say, in Ragoon you

would infringe the law if you cut it down without the permission of the Forest Department and even then you might have to pay Government a royalty on the timber.

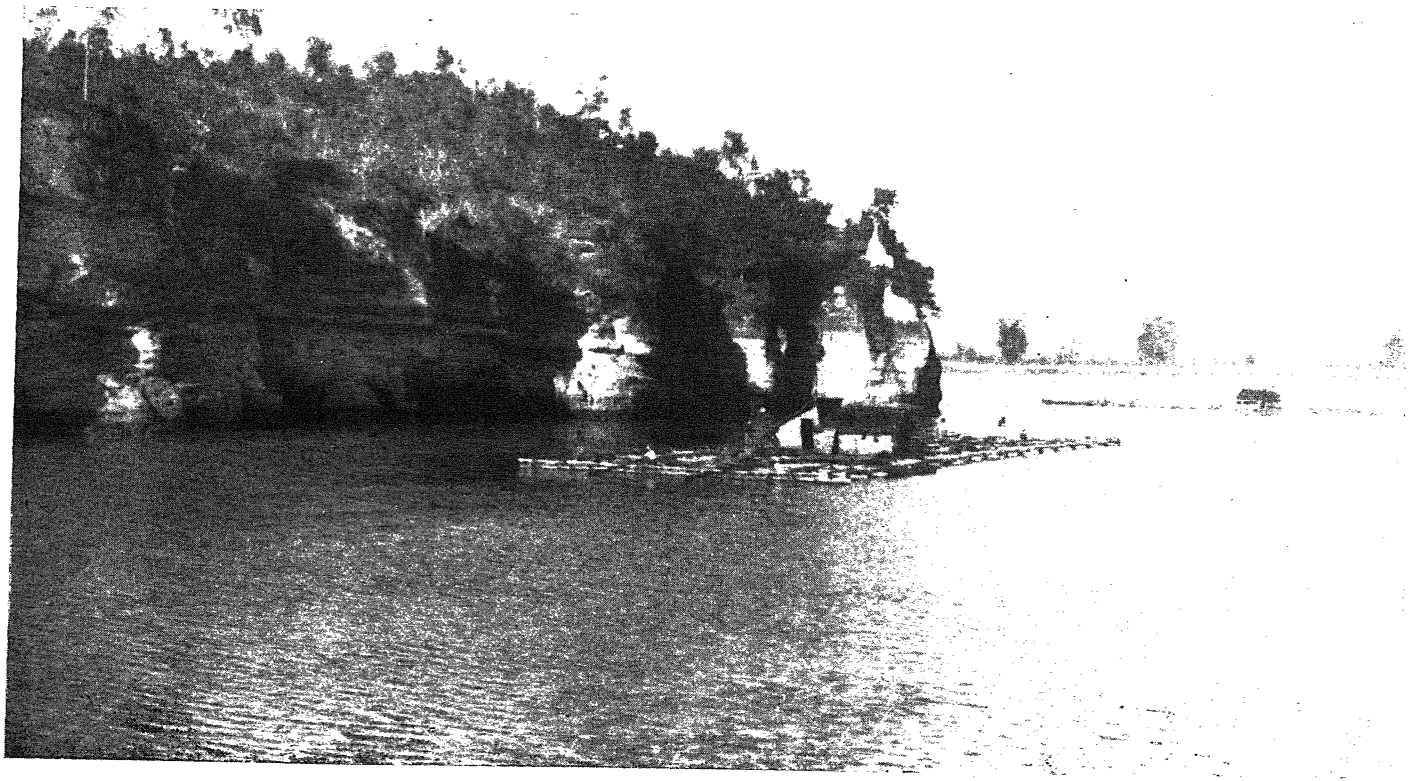
All the forests where the Teak tree grows are Government property and cover thousands of square miles of undulating country, often steep and hilly, full of large trees of various species among which Teak is very far from predominating. Standing in one spot you may be able to pick out half a dozen Teak trees but you may have to toil up half a mile of steep hillside before you see another. In many of the forests the cost of making any form of rough cart track would be prohibitive, besides demanding exceptional engineering skill, and consequently the Teak industry is entirely dependent for its primary operations on its faithful servant, the Elephant, for even the modern tractor would be powerless to operate among the rocky gullies and slopes through which the logs have often to be extracted. The Elephant in its more menial capacity has to carry the camp kit of the Forest Officer and his men when visiting the Forest. It provides the transport of the firm's timber assistant and his men who will work the timber and only when it ceases to be a beast of burden and starts to work timber does it have an opportunity to show its real merits. This sounds very noble but in point of fact the idea fails to appeal to the Elephant, for many of them grumble and trumpet most resentfully during the operation of dragging and when it comes to a maximum effort even the most silent of them usually lets out a truly expostulating bellow.

However, instead of wandering off on the subject of elephants, we ought to get back to the tree and the method of working it. Under modern conditions the first operation is that of the Working Plans Forest Officer, who makes a close survey of a block of forest, a job which will probably occupy him for several years. He will decide on the natural boundaries and demarcate the compartments, into which he will subdivide the whole forest, by blazing and hammer-marking trees at intervals along natural boundaries such as ridges and creeks. This done, he will measure accurate acreages in numerous compartments and by counting every tree of any important species and measuring them at breast height will determine the exact stand of timber by species on the plot and finally by a process of multiplication get a grand total for the forest which is, in 99 times out of a hundred, hopelessly inaccurate. However, the whole business is not quite so senseless as it seems, for the plan will be the basis of controlled working and many of the inaccuracies will be ironed out in the process of time. The plan will probably be designed to cover all work for thirty years and it will determine the breast girth above which the Teak appears to deteriorate under local conditions of soil and rainfall. For example, he may split the forest into 150 compartments and say the Teak goes off after it has attained a seven foot girth.

The reason for spreading the work over so long a period as thirty years is because Teak, like Stinkwood and Yellowwood is very slow growing, with a rotation approaching 200 years, and the assumption is that, if all the trees over seven foot are taken out during the life of the plan, their place will have been taken by the trees now in the six to seven foot group when the plan is revised and the Compartment worked again in thirty years' time. Thus continuing right down



Female elephant working in stream.



Logs on a tributary of the Irrawaddy. Note crew's huts.

the scale to the seedlings, forests worked with this degree of foresight should be capable of providing a regular supply of timber in perpetuity.

In the dry season, when the sap is falling, the Forest Girdling officer, with gangs of men, will enter the five prescribed compartments and, by cutting a two inch wide ring through the bark and sapwood, kill all the trees over seven foot girth, after leaving an adequate number of the finest and best situated as seedbearers.

For three whole years, these drying trees may not be touched, for it is a criminal offence to fell any green Teak tree without permission and, in any case the log has to be water borne to the sawmill and will not float until it is dry. At the end of this time, the lessee's working camps will move into the forest when the rains have started and the grazing and water are adequate. Each camp will consist of a native Headman, five to ten elephants with their riders and assistants and a gang of fellers. The camp may have to be occupied for three years, so substantial quarters for the men will be built in the native style. It will be raised on posts 10 to 12 feet above the ground—out of reach of a tiger's stretch—and will be thatched with grass with walls and floor of split bamboo. The site will be alongside a stream with a convenient pool adjacent in which to bathe the elephants.

The fellers working in pairs will fell the trees with a saw, flush with the ground so that no valuable timber is wasted, and as soon as there are sufficient logs on the ground, dragging will commence. The elephants in the meantime have been let loose to graze with their forelegs fettered together so that they cannot wander so far that they cannot be tracked and brought back to camp daily. As an elephant feeds he throws a good deal of earth and rubbish onto his back to protect his thick but sensitive skin from biting flies, so he will start the day's work with a really good wash. A vigorous scrubbing with a half cocoanut husk or a bath brick will ensure that when the dragging harness is put on, there is no dirt left to cause abrasions.

The headman will have set out the tasks and the logs will be broken out from stump to the main dragpath by the more powerful elephants and there the second class tuskers and females will take them on. In the rainy season after a reasonable number of logs have been hauled along it, the drag path develops into an easy trough of slimy mud. In dry going, poles are thrown down in front of the logs to act as skids and so the log moves on to launching point which it may reach in half an hour, two days or even months. At monthly intervals a European assistant will visit the camp and spend a few days inspecting the work and checking the registers, for every girdled tree has been numbered and must be traced and every elephant has a history sheet which records its age, marks and everything that has ever happened to it.

In the actual process of dragging the man who is working the elephant usually does so on foot by command but some animals are too refractory unless they are ridden, and it is always a safe rule for a European to keep out of reach of a trunk, for, while dragging, an elephant never seems to appreciate friendly interest.

In difficult country, the working camps are supplied with pulleys and wire rope which are used for hauling logs up from the gullies, where they have been felled, on to the dragpaths. Sometimes a large batch of trees are found in a punchbowl and a carefully graded track

has to be made, up which the logs are hauled by relays of block and tackle. Reaching the top, they may be sent down a rough shute and then undergo another long spell of dragging. If the country is flat and the stream still distant the logs will be loaded on carts and hauled by buffaloes. Sometimes logs which have been cut in June do not reach launching point till 9 months later when the country has dried and carts can be used In any case, the work of removing all the logs from a compartment is almost always spread over three or four years, in order that the grazing may not be eaten to extinction in one season, and the camps may be spread out so that attention can be given to the logs in the floating stream It can therefore, be taken for a fact that, on an average, no log can reach launching point until five years have elapsed since the Forest Officer girdled the tree.

In most cases the launching point will be in a narrow rocky creek, full of boulders, some of which may have to be blasted away, and with not more than a few inches of running water in it, and the logs are laid there with reasonable spacing to await the rain and the periodic floods. In these streams the rise of water seldom lasts for more than an hour or so and the torrent is so fast that not even an elephant can enter it. When the spate comes, the logs start on their journey and may travel two hundred yards or two miles before they jam but periodically the elephants are sent down the stream to clear the obstructions and space out the logs once again. It is on this work that an elephant has the chance to show its amazing intelligence and sure footedness. With the flexible pad of its foot and its astounding sense of balance it can get a firm stance on slippery rocks, where a man can hardly move, and even drag logs from this position. When using his tusks to push logs aside it seems to appreciate the key logs better than its rider and is thus able to obviate any sudden and dangerous collapse. I remember one very difficult jam in a narrow gorge which seemed utterly ungetatable until a magnificent old tusker was induced to walk up a huge balanced log, seesaw it down and start the work from the other side.

In any one stream there may be half a dozen floating rises in a season, there may be none, but the further the logs travel the easier their journey becomes until they reach the wide deep streams and so into the main rivers. Less than half of the logs lying in the creeks will reach their destination in one season and except when the flood is on, they are reposing high and dry, continuing the process of seasoning.

As soon as the logs have passed from the rocky streams into the navigable rivers they are caught and made up into rafts of about 100 logs each. Small huts are built on the raft to accommodate a crew of 4 or 5 men and, as water and weather permit, they are floated down to the main rafting stations on the Irrawaddy River. There they will wait till the river falls to its dry weather level, for during the rains it is two to five miles wide and when the wind blows, the rough water would break up the construction in a very short time. During the halt, the timber is classed according to the hammer marks denoting the forest from which it came, each log is measured accurately and the royalty due to Government is paid on it. The opportunity is also taken to rebuild the rafts more substantially and increase the

size to about 130 logs and early in November the exodus for Rangoon will commence. By then, the channel will not be much more than half a mile wide and, with a moderate current and little wind, the journey to the timber ponds should not take more than two months. And so after operations which started some eight years before and a journey of sometimes over a thousand miles, we can leave the log at the disposal of the Sawmiller.

SOUTH AFRICA'S DEBT TO JOSEPH BURTT DAVY

By MARY GUNN

(*Librarian, Division of Botany, Pretoria.*)

JOSEPH Burtt Davy, M.A. (Oxon.), Dr.Phil. (Oxon.), Ph.D. (Cantab.), F.R.G.S., F.L.S., whose death occurred at Oxford on the 20th August, 1940, was born on the 7th March, 1870, at Findern in Derbyshire. His loss will be felt the more by South African botanists as his "Flora of the Transvaal and Swaziland," of which two volumes have already been published, was at the time of his death still uncompleted.

During 1891 and 1892 Burtt Davy was an assistant in the office of the Director of the Royal Botanic Gardens, Kew, but resigned after a year's service owing to ill-health and went to California. He worked at the Berkeley University as a research student and held various botanical posts. For a short period during 1902 he was an assistant in the United States Department of Agriculture, and during his stay in America wrote several papers on the vegetation of various parts of the country.

His connection with South Africa commenced in 1903, when he was appointed Agrostologist and Botanist in the newly established Transvaal Department of Agriculture. In this capacity he laid the foundation of a Colonial Herbarium that has since developed into the present National Herbarium. Burtt Davy was very interested in the subject of plant introduction, and devoted much time to the introduction of seed and plants that were tested out at the various experiment stations. An outstanding success of his was the introduction of teff as a forage crop. His interest in plants was wide and many of his publications deal with poisonous plants and weeds.

In January, 1907, he took charge of the South African Productions Exhibition in London, and while overseas took the opportunity to visit Southern Europe and Northern Africa to study methods of growing certain warm temperate crops and also to obtain seed of crops that he considered particularly adaptable to Transvaal conditions. He also paid a visit to America to study methods of plant breeding with particular reference to maize. While in England he worked in the herbarium of the Royal Botanic Gardens at Kew, studying the types and authentically naming specimens of Transvaal trees. This resulted in the publication of his "Geographical Distribution of the Native Trees of the Transvaal."

In 1908 he was instrumental in establishing a large maize breeding station at Vereeniging. His interest in maize resulted in a comprehensive work published in 1913 under the title, "Maize, its History, Cultivation, Handling, and Uses," which remained until quite recently the standard South African work on the subject. His interests and activities in South Africa covered a wide range. Amongst other offices held by him was a technical membership of the committee appointed to inaugurate the Pretoria Zoological Gardens.

At the time of Union, the Transvaal was the only province that had an organised Division of Botany, and Burtt Davy, as its Chief, continued to hold office as Government Agrostologist and Chief of the Union's Division of Botany. He resigned this post in 1913 in order to engage in the breeding of farm seeds on his own account at Vereeniging.

After the last war, he left South Africa for England where he commenced his work on "The Flora of the Transvaal and Swaziland" to which reference has already been made. In 1925 he was appointed Lecturer in Tropical Forest Botany at the Imperial Forestry Institute, Oxford, and retained the post up to his death. During the tenure of his lectureship he was responsible for the training of many students who later filled forestry posts in the Colonial Service. Through the students who passed through his hands he built up a large forestry herbarium at Oxford, comprising material from all over the British Empire. While at Oxford he was one of the co-editors of a series of publications entitled "The Forest Trees and Timbers of the British Empire," of which the following are of particular interest to South African botanists, foresters, and timber investigators :—

Some East African Coniferae and Leguminosae.

Fifteen South African High Forest Trees.

Ffteen Uganda Timbers.

The younger generation of South African foresters enjoyed the privilege of meeting this distinguished forest botanist, already, by earlier residence, known to their elders, on the occasion of his visit to the Union in 1929 as a delegate of the Forestry Section of the British Association for the Advancement of Science, during which he took the opportunity by personal collection of further enriching the Forest Herbarium at Oxford.

Dr. Burtt Davy has without doubt left his mark on South African botany and agriculture, and during his residence in the country gave loyal and distinguished service. A former Secretary for Agriculture, in one of his annual reports, wrote, "During the time he was in the Government service, Mr. Burtt Davy performed an immense amount of most valuable scientific and educational work, and the services he rendered the country, particularly in connection with the popularisation of teff grass, and the assistance and impetus he gave to mealie growing, will always be regarded as landmarks in the history of South African agriculture."

OPRIGTING VAN 'N DRAADHEINING TE KOMATIPOORT

DEUR H. L. DE GEUS

(*Division of Forestry, Pretoria.*)

EINDE Desember 1938 is die Afdeling Bosbou deur die Sekretaris van die Departement van Landbou en Bosbou versoek om 'n draadheining op te rig op die grens tussen die Unie en Mozambique, vanaf die Komatirivier in die Noorde tot by Swaziland in die Suide. Die doel was om te verhoed dat mond- en klouseer, wat onder die beeste en wild in hierdie gebied gewoed het, sou versprei.

Om aan hierdie vereiste te voldoen, was dit van belang dat die werk so spoedig moontlik sou begin en voltooi word. Gevolglik was daar slegs enkele dae beskikbaar vir voorbereiding en organisasie.

Die grenslyn, waar die heining opgerig moes word, het bo oor die Lebomboberge gegaan en ongeveer met die waterskeiding daarvan saamgeval. Hierdie berge is laag, maar baie gebroke en rotsagtig van geaardheid; daar is verskeie ewewydige reekse naby mekaar geleë en op sekere plekke gaan die grens van die een reeks op die ander oor en loop daar deur valleie of vlaktes wat gewoonlik moerasagtig is.

Daar was slegs enkele kaarte van hierdie streek beskikbaar, opgestel van opmetings deur Pizighelli in 1906-07 en Boshoff en Matthews in 1928. Slegs laasgenoemde kaart het informasie oor ses van die sestien hoofbakens gegee. Topografiese besonderhede was onbetroubaar daar dit slegs op die kaarte ingeskets was. In sommige gevalle, waar die bakens nie van sement gebou was nie, was hulle vervalle en moeilik om te vind daar plantegroei dit vir die oog verberg het. Op die Noordelike deel van die lyn is baie klein bakens gevind wat in die loop van tyd opgerig is en nie offisiëel was nie; hulle was nie op die regte lyn geplaas nie en was misleidend. Sodra die hoofbakens egter vasgestel was, kon die lyn met 'n teodoliet bepaal word. Daar die afstand tussen hoofbakens op sommige plekke meer as sewe myl beloop het, en as gevolg van die gewoonlik deinserige lug en die feit dat so 'n lyn oor heelwat bergtoppe en deur klowe geloop het, was dit moeilik om die draad aan die vereiste, dat dit oorals presies met die grens sou saamval, te laat voldoen.

Voorlopige inspeksie is verder bemoeilik deurdat daar geen paaie naby die grens was nie. Die hoofpad van Komatipoort na Stegi in die Suide, gaan deur die Lebombovlakte; van hieruit het twee ou paaie deur die vlakte, na die berge ten Ooste daarvan en die grens geloop. Hulle was baie verspoel en na reens onbegaanbaar vir motortransport, daar die grond oor groot afstande moerasagtig is.

'n Voorlopige kamp is begin Januarie opgeslaan naby die baken Matibaskom; tente met dubbel muskietgordyne is verskaf en aangesien malaria in hierdie streke baie gevaarlik was, is iedereen gewaarsku om nie na sononder buite te wees nie. Nieteenstaande kinine, kalomel en ander malaria genees- en voorbehoedmiddels vry uitgedeel en die



FIG. i.—Vervoer van materiaal en water.



FIG. ii.—Stadige vordering deur die bos.

tente daagliks met gekonsentreerde „Pyagra'' gespuit is, het heelwat gevalle van koors voorgekom en moes werksmense na die dokter te Komatipoort en na die hospitaal te Barberton geneem word.

Voorsiening van voldoende water vir die kamp was steeds 'n probleem; hoë verbruik was vanselfsprekend as gevolg van die warmte —die temperatuur was, behalwe op reendae, gereëld bo 100°F en menigmaal naby 120°F. Veertig gelling staal dromme is op die vragmotors gelaai en volgemaak (figuur 1); soms moes die water oor 'n afstand van meer as 20 myl aangery word.

Die keuse van 'n kampplek is natuurlik ten eerste bepaal deur nabyheid aan die werk; daarna was aanwesigheid van water, 'n so hoog moontlike ligging en ook toeganklikheid van belang. Na gelang die werk gevorder het, moes die kamp verskuif word. Dis nie doenlik gevind om die werk meer as vier tot vyf myl aan weerskante van die kamp te laat uitstrek nie, aangesien beskikbare arbeidskragte gedurige en direkte toesig vereis het.

Die kamp was onder bevel van 'n Bosbeampte bygestaan deur 'n Bosbouer. Verder was daar drie tot vier voormanne en vier tot ag nedersetters van die Nelsrivier en Tweefontein nedersettings in die Nelspruit en Sabie bosdistrikte. Twee drywers van die Goewermentsgarage te Pretoria het met twee 4-5 ton vragmotors alle vervoerwerk gedoen. Kaffers is plaaslik gehuur en die aantal het van plek tot plek van 20 tot 150 afgewissel. Veral na betaaldae het soms meer as die helfte verdwyn. Hulle was gehuisves in tydelike hutte en afdakke, deur hulle self gebou.

Aan die einde van die eerste maand is 'n beampte van Hoofkantoor gestuur om die arbeiders te betaal maar as gevolg van 'n uiters swaar reen kon die vragmotors, wat die betaalmeester en die geld moes ophaal, nie Komatipoort op die vasgestelde dag bereik nie. Die volgende dag is weer 'n poging aangewend; die twee partye het mekaar halfpad ontmoet en die geld is daar in die veld op 'n seepkis uitbetaal. Toe die beampte na Komatipoort teruggeneem is, is een van die vragmotors byna deur die Komatirivier, wat in vloed was, weggespoel. Dit was alles onbevredigend en later is die geld per pos gestuur om in die kamp uitbetaal te word.

Die eintlike werk het ongeveer 5 Januarie begin sodra die werksmense aangekom het en die kamp opgeslaan was. Voedsel en gereedskap is in groot hoeveelhede na die kamp, waar 'n dêpot gemaak is, aangery. Die ou pad is begaanbaar gemaak tot waar dit, ongeveer 25 myl van Komatipoort, oor die grens gaan (sien kaart, bls. 14). Daarna is, so na aan die grenslyn as moontlik en al langs die berghellings en bo op die plat bergrugge, roetes gevind vir die vragmotors, sodat die materiaal aangery kon word. Dit was doenlik om oorals tot op die lyn, of binne 'n afstand van een myl daarvan, te kom. In sommige gevalle is slegs die grootste klippe weggeruim en bome uit die pad gekap. Ongeveer 40 myl van hierdie paaie is uitgelê, meerendeels op Portugese gebied. Die feit dat dit gedoen kon word sonder graaf- en skietwerk, het 'n aansienlike hoeveelheid tyd en geld bespaar, en dit was vir 'n groot deel te danke aan die vaardigheid van die drywers. Hulle het met die vragmotors op hierdie slegbegaanbare weë uitstekende werk gelewer. (fig. 2).

Tegelykertyd is begin met oopkap, op die grens, van 'n 10-30 tree wye lyn. Vordering het afgehang van geaardheid van die grond en die

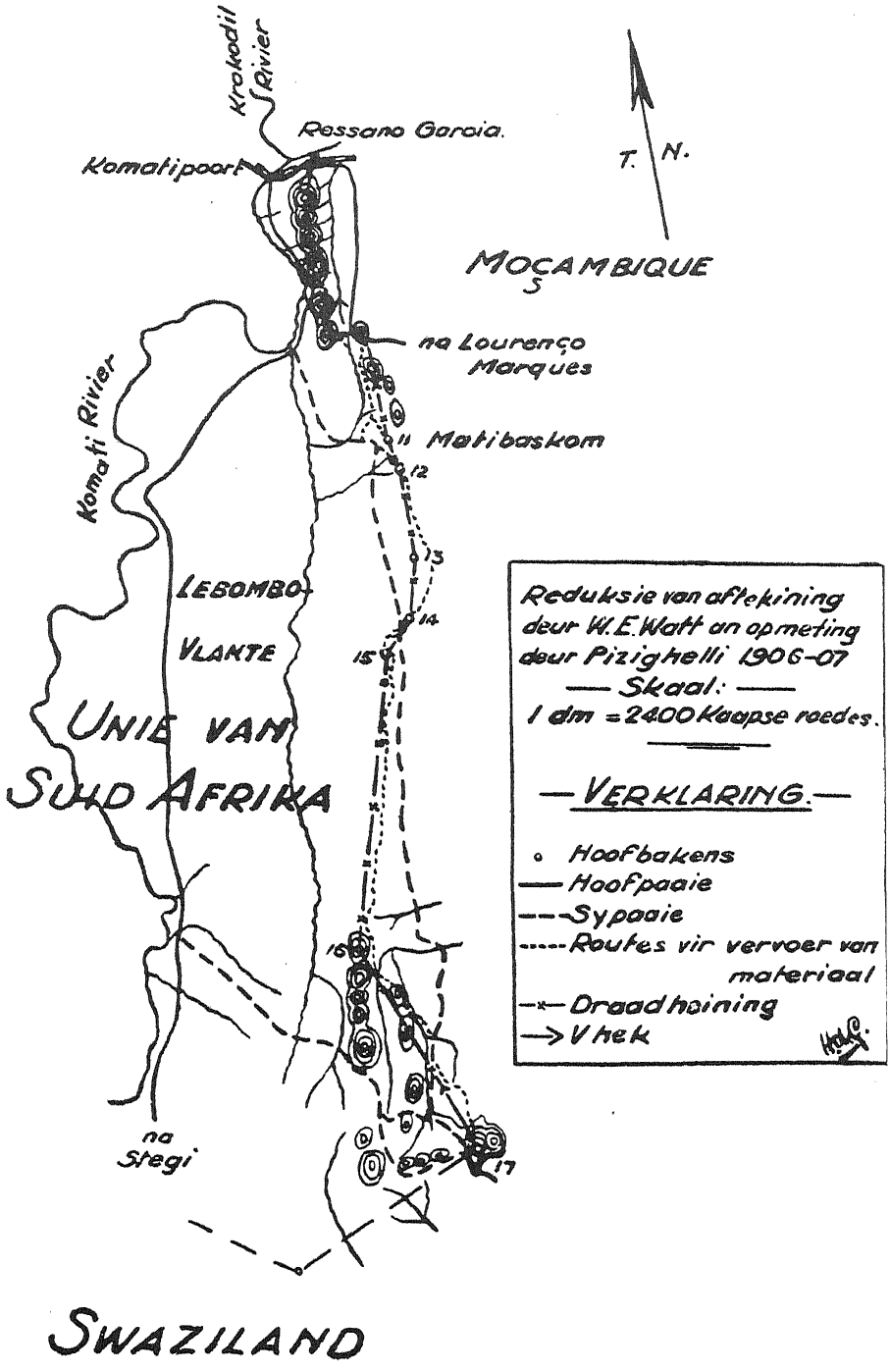

Krokodil Rivier
Rossano Garcia.
Komatipoort
T.
N.
MOÇAMBIQUE
na Lourenço Marques
Komati Rivier
11 Matibaskom
12
13
14
15
LEBOMBO
VLAKTE
UNIE VAN
SUID AFRIKA
16
na Stegi
17
SWAZILAND
Reduksie van aftekining deur W.E. Watt en opmeting deur Pizighelli 1906-07
— Skaal: —
1 dm = 2400 Kaapse roedes.
— VERKLARING. —
Hoofbakens
Hoofpaaie
Sypaaie
Routes vir vervoer van materiaal
Draadheining
Vhek



FIG. iii.—Ysterpaal op rots.



FIG. iv.—Padaanlê in moerasagtige grond.

plantegroei. Soms is skaars honderd tree, dan weer 'n paar myl per dag gedoen. Die meeste boomsoorte in hierdie droër streke is uiters hard en in die klowe by Swaziland is dele dig bebos. Die grenslyn is vervolgens met vlae noukeurig afgesteek en 'n span, met koevoete en pikke gewapen, het rotsblokke en ander hindernisse verwyder. Daarna het 'n span gevolg, wat die pale, draad, hangers ens. op die regte afstande oor die grens versprei het; dit moes deur mense gedra word vanaf die plekke waar die vragmotors dit kon aflaai. Agter hulle weer was 'n voorman in bevel van die span, wat ysterpale ingeslaan het. In die rotsagtige grond was dit in plekke onmoontlik en staalbore is gebruik om gate vir die ysterpale in rotse te boor (figuur 3). Die bore is in die kamp, met behulp van 'n draagbare blaasbalk, deur 'n smit skerp gehou. Ook is toetse gemaak met ronde staalpenne, ongeveer 2 voet lank en 1 duim deursnee bo, wat na 'n skerp punt aan die onderkant afgeloop het. Op klipperige grond is eers die penne ingeslaan waarna die pale makliker in kon gaan; laasgenoemdes wou egter nie vas staan nie en geen verder gebruik is van die penne gemaak.

Die hout trek- of wenpale is deur 'n volgende span op hulle regte plekke ingeplant. Waar die geaardheid van die grond dit toegelaat het, is aan weerskante van bakens en by hoeke „bokse" gemaak, wat bestaan het uit twee houtpale, 3′ 6″ vanmekaar, met 'n horisontale dwarsstuk tussen die bopunte ingelaat en stewig met dubbel, gedraaide No. 8 kruisdrade aanmekaar vasgewoel. Op ses plekke in die lyn is V-vormige hekke gemaak om naturelle in staat te stel om water aan die ander kant van die heining te haal en tegelyktertyd deurgang van diere te belet.

Die grootste span was voortdurend besig met die draad. Rolle doringdraad, elk 450 tree lank, wat op die regte afstande van mekaar gelê het, is afgerol deur kaffers wat voortdurend hierdie werk verrig het en dit naderhand uitstekend kon doen, selfs op styl hellings. Die draad is daarna met trekkers op die regte spanning gebring en eers aan die hout wenpale en daarna aan die ysterpale daartussen bevestig. Dis belangrik dat draad tot die regte spanning getrek word; dit moet so styf moontlik wees en toelaat vir uitset en krimp met temperatuur skommelinge; as dit te strak is, sal dit breek wanneer swaar wild daar in volle vaart teen aanloop—wat nogal dikwels voorkom; by korrekte spanning sal die heining as 'n skokbreker werk en veer maar nie breek nie. As die wenpale aan weerskante van 'n duik of kloof staan, hang die draad in die lug en moet dit langsaam afgetrek word om aan die ysterpale vasgemaak te kan word. Die draad oefen in so 'n geval 'n krag, wat loodreg na bo gerig is, op die ysterpale uit; om te verhoed, dat laasgenoemde uit die grond getrek word, word hulle op plekke vasgeanker aan groot klippe wat langs die pale in die grond gegraaf word. In moerasagtige valleie moes soms oor groot afstande alle pale so geanker word.

Die heining is voltooi deur 'n laaste span, wat die hangers—en op baie plekke ook weer ankers daaraan—bevestig het.

Deur die werk te organiseer en aan elke persoon sy bepaalde onderdeel daarvan toe te wys, kon dit soveel moontlik bespoedig word. Vir 'n kort tydperk is die kamp in twee gesplits, die een seksie het vooruit gewerk en die ander het die werk agter voltooi.

Aangesien die heining teen beeste en wild bestand moes wees, is 'n sterke tiepe opgerig met die volgende soort materiaal:—

(a) hout wen- of trekpale, 7 voet lank met 5-6 duim deursnee aan die dun ent, behandel met kreosoot en olie; hulle is op ongeveer 400 tree van mekaar en ook aan weerskante van bakens, by hoeke, V vormige hekke ens., geplaas.

Dit mag eienaardig lyk dat behandelde houtpale gebruik is, terwyl daar tog uitstekende en duursame pale uit die inheemse savannah bosse naby die lyn verkrygbaar was. Soos egter reeds van tevore gemeld, was die meeste houtsoorte uiters hard en voorbereiding van 'n voldoende aantal pale sou te lang geduur het.

Die behandelde materiaal was by die preserveringsinstallasie van die Pan Plantasie, naby Middelburg, Transvaal, in voorraad en kon onmiddelik aangestuur word. Ook is dit waarskynlik dat laasgenoemde pale meer gelykvormig en reguit is, as die wat uit die bosse gekap sou gewees het.

(b) 6 voet lank ysterpale, van 14 lbs. elk, met 6 gate.

(c) 48 duim yster hangers, H-vormig in deursnee.

(d) No. 12, tweedradige gegalvaniseerde doringdraad, met vierpuntige dorings 6 duim van mekaar om altwee drade gedraai.

(e) No. 8 gegalvaniseerde gladde draad, vir ankerwerk, hekke, ens.

(f) No. 10 gegalvaniseerde gladde draad vir bevestiging van die doringdraad aan pale en hangers.

Die drade was, van onder na bo, as volg gespasieër: 12dm., 6dm., 9dm., 12dm. en 13dm. Die boonste draad was dus 4 vt. 4 dm. bo die grond.

Die werk het iets langer as drie maande geduur. Vertraging is ondervind deurdat gereedskap en materiaal aan die begin stadig ingekom het en ook as gevolg van swaar reens. (Teen die ent van Januarie het bv. in een nag 7 dm. reen binne vier uur geval). Paaie was soms vir dae lank onbegaanbaar en driwwe van groot klippe moes deur menige stroom gebou word. In moerasagtige dele is die sagste plekke met rotsblokke en klippe opgevul; op 'n sekere punt is veertig 4-ton vragte hiervan oor ongeveer sestig tree pad gedeponeer voordat die vragmotors kon deurkom (fig. 4).

Die opgerigte heining was ongeveer 42 myl lank. Die koste het omstreeks £71 per myl bedra en kan as volg persentasie gewys opgedeel word:—

Spoorvrag en vervoerkoste	15.8
Materiaal	47.3
Gereedskap	2.3
Verteerbare en verbruikbare voorrade ...	2.9
Lone	26.3
Verblyfskoste en onderhoudstoelaes ...	4.9
Mediese onkoste	0.5
TOTAAL	100.0

Die koste van toesig, wat uit die salarisse van die Bosbeampte en Bosbouer en die inspeksie-koste van die Bosbewaarder bestaan het, is nie hierby ingesluit nie.

Die volgende hoeveelhede materiaal is gebruik:—

742 rolle (van 100 lbs. elk en 450 tree lank) doringdraad.
18 rolle (van 100 lbs. elk) No. 8 gladde ankerdraad.
47 rolle (van 100 lbs. elk) No. 10 gladde binddraad.
541½ dosyn ysterpale
1,107¾ dosyn yster hangers.
244 houtpale.

THE GROWING OF *POPULUS DELTOIDES* IN SOUTH AFRICA

By E. L. SCHIEMER
(Lion Match Company, Durban.)

Origin and Introduction

THE species *Populus deltoides* is also known as Cottonwood or Carolina Poplar. The latter name indicates its origin in the State of Carolina, U.S.A. It is one of the American Black Poplars of the Section *Aigeiros* Duby.

The exact date and manner of its introduction into South Africa are, unfortunately, unknown. Hubbard (1) states that in the annual report of the Transkeian Conservancy for 1911 a tree in Umtata is mentioned as the source of supply of cuttings. This tree which was fourteen years old in 1911 and measured 11 inches in diameter at breast height and 40 feet in height, was growing on the property of the late Mr. C. C. Henkel. When and how it came to Umtata is by no means certain. According to Hubbard, a Dutch Reformed Minister probably brought it there in 1896/97, and the cutting or young tree was thought to have originated from trees then growing at Ceres. The latter were estimated to be about 15 years old. If this is correct they must have been planted round about 1880. When the late Mr. Henkel's farm near Umtata was visited, the writer was informed by the present owner that a few old *deltoides* trees had been removed some years ago. Actually three stumps were found which measured from 12 to 14 inches in diameter.

In the course of further enquiries into the introduction of *Populus deltoides* into this country, two trees on Mr. Pringle Scott's farm "Glen Etive" near Tarkastad were encountered. These trees measured 39 and 44.2 inches in diameter respectively at breast height in October, 1938. Both were 65 to 70 feet high. According to Mr. Scott they were planted by his father approximately 60 years ago. They would thus be of the same age as that estimated for the above-mentioned Ceres trees. The origin of the former trees was traced to an old *deltoides* on "Lyndoch" near Bedford. The owner, Major Pringle, claims that his tree is the oldest in the country. In 1939 it measured 49.3 inches in diameter at breast height and was 75 to 80 feet high. Major Pringle states that this tree was planted some 60 years ago, but unfortunately no further information as to its origin could be obtained.

As there is some doubt as to the correct name of the species known in South Africa as *Populus deltoides var. missouriensis*, it would be of great interest to find out by whom and whence the first tree was imported.

Until 1909 it was propagated in South Africa under the name of *Populus macrophylla*. Then the late Prof. Henry examined herbarium material sent to him by the Department of Forestry and confirmed

that it was actually *Populus deltoidea var. missouriensis*. Comparing the descriptions given by Henry and other authorities on poplars the author is rather inclined to believe that our *Populus deltoidea* is identical with *Populus angulata*. However, the opinions in connection with the name and synonomy of this tree differ considerably. More particulars about this matter are given by Dr. Houtzagers (2). This poplar expert suggests the name of *Populus deltoides* Marshall *var. missouriensis* Henry for the American tree and *Populus angulata* for a mutation which originated in Europe and which is somewhat different from the original American variety *P. deltoides* Marshall *var. missouriensis* Henry.

It is more likely that our South African *P. deltoides* was imported from Europe (England or Holland) than from America. If this is correct, it is in all probability identical with the European mutation of the American variety. Material has been sent to Dr. Houtzagers for identification and further investigations into this matter are proceeding.

Site Requirements

As in the case of other poplars, *P. deltoides* is a light demanding and moisture loving tree. It is the most exacting of all the poplars in this country as regards soil and moisture conditions. For successful growth the best possible conditions are required. The soil must be deep, fertile, well-watered, well drained and aerated. These conditions prevail on riverbanks and in valleys, where the soil is usually of an alluvial nature and of medium porosity. Reed vleis are ideal poplar sites, provided that the soil is not a very stiff clay (pot-clay) and can be reasonably well drained. A certain amount of free drainage is essential because high acidity and stagnant water are fatal to *P. deltoides*. On the other hand, occasional flooding is tolerated as there is usually a sufficiently constant flow of water round the roots, while the silt deposited when the waters recede is of great nutrient value to the trees.

There are fairly extensive plantations in the Umvoti vlei (Natal) and in the Annysspruit valley near Piet Retief (Transvaal), where the trees are regularly flooded several times during each spring and summer. These are probably the very best *deltoides* plantations in South Africa. In Northern France, also, where poplars have been planted on a big scale in the marshy valleys of the Seine and its tributaries, inundations during winter and spring are a common feature and the splendid growth of the trees is proof that these floods are not injurious to them.

Although *P. deltoides* will grow fastest on an alluvial vlei soil, it will also grow very satisfactorily on a more sandy site at low elevation, provided that there is an adequate supply of moisture and the soil is not exhausted. By moisture is meant, of course, rainfall as well as subsoil moisture.

While in a vlei the growth is less dependant on the rainfall, on other sites *P. deltoides* should not be planted for commercial purposes in areas which receive less than 25 inches of rain during the spring and summer. In conditions less favourable than these the best results cannot be expected, and although the trees survive they cannot be grown on a commercial scale. In illustration of this point it may be mentioned that large plantations were established in the inland districts of the Cape Midlands some 10 years ago. To-day only very small portions of them are left and these are not vigorous.



FIG. i.—Two year old *P. deltoides* on edge of Umvoti vlei. Pruning of lower laterals has already commenced.

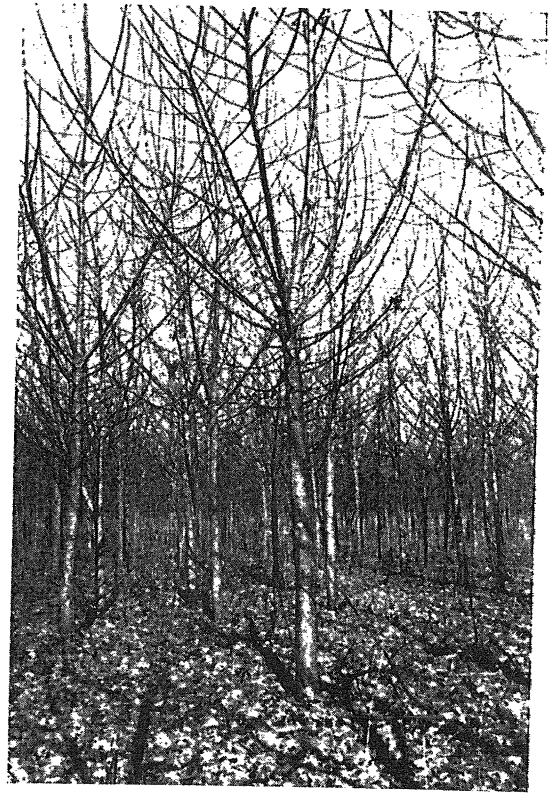


FIG. ii.—Three year old *P. deltoides* showing the necessity for and importance of crown-trimming.



FIG. iii.—Degree and method of pruning.

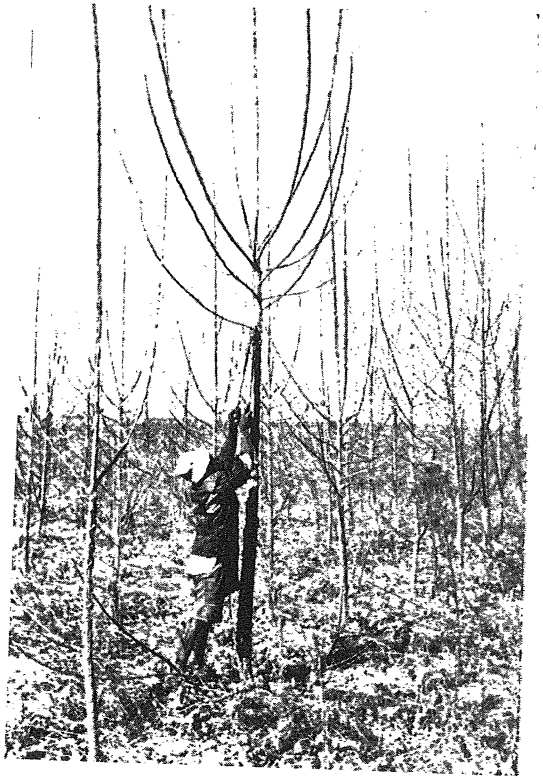


FIG. iv.—Three year old coppice on the farm Came, Natal.

This disappointing result of extensive and expensive planting operations is partly due to the shallowness and the high acidity of the soil, but mainly it is thought, to the fact that the average annual rainfall is only 17 inches. During the last few years only 7 to 10 inches have been registered.

It has sometimes been stated that *P. deltoides* will not grow in a sub-tropical climate or near the coast. However, in all cases known to the writer where it was planted in coastal areas without success, the failure seemed to be due to severe droughts in these special localities. There are several small but excellent *deltoides* plantations in and near George, only a few miles from the coast. Near Verulam, 25 miles north of Durban and only 5 miles from the coast as the crow flies, there are approximately 30 acres under *P. deltoides* which are growing with exceptional vigour. Of course, they were not planted on a dry site, but on the banks of the Umhloti River which flows perennially and comes down in flood occasionally, its water sweeping through these poplar stands and depositing large quantities of silt. Although some of the younger stands in this plantation were rather overpruned in the early stages and deprived of practically all their laterals during the first three years, they have managed to put on a diameter increment of as much as one inch per annum. There is another *deltoides* plantation near Port Shepstone on the Natal South Coast, which has done remarkably well. On the farm of the Umlaas Road Waterworks near Camperdown, *P. deltoides* is growing on approximately 20 acres of the marshy banks of the Umlaas river. Here may be found 5 year old trees with diameters of 9 and 10 inches at breast height. Fig. 7 shows stem sections of one of these trees. The timber was tested for matchwood and in spite of its youth and its extremely quick growth it was found to be of a very good quality. Excellent *deltoides* plantations are also found in East Griqualand 6,500 feet above sea level.

This poplar variety can thus be grown successfully at sea level in a distinctly subtropical climate, as well as at altitudes up to 5,000 and 6,000 feet. While it can withstand high temperatures provided there is an abundance of sub-soil moisture, a sharp frost in winter will not harm it. It does not, however, grow well in wind swept areas. Late frosts may occasionally affect it in that the young leaves and shoots get frosted. Normally they will soon recover, however, and only a slight setback results.

Method of Propagation

The usual method of raising *P. deltoides* is from cuttings. Apart from the fact that this is very easy, propagation from seed would be impossible, as the trees in this country are exclusively male.

As a rule the cuttings are lined out in a nursery, where they remain for one year before they are transplanted as rooted cuttings. The best material for making these are one year old branches or stoolshoots obtained from 3 to 5 year old trees. Older wood is not so satisfactory for the purpose.

The cuttings should not be longer than 9-12 inches, with a truncated upper end, so that after planting in the nursery the new shoot develops from a lateral bud close to ground level. Their thickness should not be less than 1/3 of an inch or more than ¾. They must be cut with a sharp knife at an angle of 45 degrees. It is preferable

to make the top cut just above, and the bottom cut just below, a lateral bud. The best season for taking and lining out the cuttings in the nursery is July to August.

They strike best in a deep rich loamy soil with an abundant underground water supply or under irrigation. Under such conditions practically 100 per cent. of the slips take root and produce strong, vigorous shoots. Regular cultivation is necessary.

Normally the plants will obtain a height of 4 feet or more during one season and the root system will develop accordingly. The best spacing is about 12 by 6 inches. In practice, however, they are often spaced only 4 inches apart or even less, but if they are too crowded weak plants are the result. Lining out in open trenches and putting the cuttings in at an angle of approximately 45 degrees is advisable. The soil must be well firmed around the slips, but this should be done with great care so as not to damage the bark.

Method and Time of Planting

At the age of one year the rooted cuttings of *P. deltoides* should be transplanted while in the dormant state. The best time is July or August. Where there is a danger of severe late frosts planting may be delayed until the beginning of September. This, however, is only possible when the rooted cuttings have not yet started growing as it has been found that cuttings which have started shooting, usually die when transplanted.

A thorough soil preparation is, generally speaking, of the greatest importance for the future development of a young *deltoides* plantation. Where the trees are to be planted on virgin soil, experience has shown that they grow much better when the ground has been broken up twice before planting, than after a single ploughing. The best time for the first ploughing is the spring (October to November) of the year before planting and second ploughing should follow in April or May. Disc-harrowing between the first and second ploughing considerably assists the decomposition of the dense mat of vegetation and roots turned over by the first ploughing. In addition the improved air circulation will result in vigorous development and activity of the micro-organisms in the ground, organic matter will be decomposed, and by the time of planting the ground should be in a proper condition to enable the roots to take advantage of all possible nourishment. Of course, if the land has been used for agricultural purposes and is in good condition, no soil preparation will be necessary.

If planting is attempted in a soil that is swampy, as vleis usually are, ploughing will in most cases be impossible for practical reasons. In most vleis the natural drainage conditions are poor and planting of *P. deltoides* should not be attempted on these marshy, waterlogged lands unless they have been properly drained at least one year previous to planting. The drainage of a swampy vlei of any extent is, admittedly, an expensive item, but the superior growth of *P. deltoides* on well drained vlei land should more than warrant a rather high initial expenditure.

If a sufficient number of drains have been dug, the water level will sink and the ground will settle. In cases where the reeds and weeds are very tall, it may be advisable to burn them off before starting any work.

There is no need to dig big holes, but it is essential that the

whole root system be covered and that none of the roots are bent upwards in the course of planting. This is not difficult as the rooted cuttings usually have a very flat root system.

After planting, the trees must be cut back to ground-level. Experience shows that this has a very beneficial effect on the growing capacity of the young trees, which produce much stronger and longer shoots than when they are not cut back. If the weather is dry, after planting it may be necessary to give each tree a watering of, say, two gallons every fortnight until the spring rains start.

A regular espacement of 8 x 8 feet is at present considered to be the most suitable in this country. This means 680 trees to the acre which may seem rather an excessive number especially as the final stand should not exceed approximately 200 trees per acre. It may be asked why poplars (including *P. deltoides*) can be successfully grown for match wood in Holland and France, planted 20 to 24 feet apart. The reason is that the practice there is to interplant them with alder and other shade-bearing trees which function as a nurse-crop. Unfortunately, no suitable tree species have as yet been found in this country for this purpose. Experiments with *Cupressus lusitanica, Pinus caribaea* and *Trema guineensis* were started last year.

Apart from these difficulties, it has been found that quite a number of *P. deltoides* develop poor shapes, mainly on account of the leading shoots being broken off by wind and the top-buds being damaged by birds. An ample margin should be allowed for failures and for the weeding out of badly shaped, damaged, or diseased trees before the crop reaches maturity. Therefore, a fairly close espacement is advisable, followed by early selective thinnings.

CULTIVATION

On good poplar soil the weeds will naturally grow very rapidly. To prevent the young trees from being overgrown or suppressed and to keep the ground in proper condition, one or more cultivations will be necessary during the first year. The more cultivations, which keep the surface soil loose and allow thorough aeration, the better the effect on the growth of the trees will be.

Where grass and weeds grow very rapidly and tall, one or more slashings may be necessary during the second year until the trees have formed a canopy and are able to suppress all undesired ground vegetation.

INTERPLANTING

A good method of keeping the cultivation costs as low as possible, is the interplanting of the poplars with field crops, such as maize, potatoes onions, beans, pumpkins, monkeynuts, etc.

Recently, *deltoides* stands, interplanted with such crops, showed a more vigorous growth than others on similar soil, which were not interplanted.

THINNING

Apart from the need of carefully selecting the trees which should comprise the final stand, thinnings will also be necessary in order to maintain the growth of the trees. The age at which the first thinning should be made, the frequency of further thinnings and the number

of trees to be removed on each occasion, will depend mainly upon the density of the crop on the ground and the rate of growth. Under no circumstances should the thinning be delayed beyond the time when the crowns of the majority of the trees begin to touch. All backward trees should be removed so as to allow the final crop trees as much light and growing space as possible. For this reason no thinning regime should be applied blindly. Common sense will tell the poplar grower when and how to thin out his plantation.

The following thinning schedule which has been successfully applied on first quality sites will, however, serve as a guide :—

Time of thinning :	Reduce number of trees to :
End of 3rd year	500 per acre
,, ,, 5th year	400 ,, ,,
,, ,, 7th year	300 ,, ,,
,, ,, 9th year	250 ,, ,,
,, ,, 10th year	200 ,, ,,

Pruning

In order to produce clean timber—knottiness will render *deltoides* quite useless for match manufacture—pruning is very important. Although the lower lateral branches start dying off on account of lack of light as soon as the crowns form a canopy, they do not immediately fall off, but persist on the stems for a surprisingly long time. In the meantime the tree is growing, its diameter increasing, and the dry branches form dead knots which are bound to diminish the value of the mature timber considerably.

When *P. deltoides* is being grown for the match industry, pruning must start early and be repeated at frequent intervals. Not only must the dead branches be removed, but it is essential to do a considerable amount of live pruning as well, especially during the first few years. If the trees are pruned in time only the residual core of the mature bole will be knotty.

In the match factories the logs can be peeled down to a diameter of approximately 3 inches and every knot in the outer layers means a certain amount of waste. Therefore the laterals must be removed as far as possible up to the height at which the diameter of the bole begins to fall below 3 inches. This is only a general rule which obviously cannot always be followed, especially in later years when the higher portions of the stem are being pruned. On the other hand, it can be only to the advantage of a young *deltoides* tree to have the lower lateral branches cut off early. These branches usually grow with great vigour during the first few years and should be removed early so as to prevent a check to the growth of the young tree. The small wounds caused by their removal will soon heal up without leaving any blemish.

In practice all bottom shoots and double leaders are removed at the end of the first year. The average height of the trees should by then be at least 4 feet. At the end of the second year the first major pruning occurs, which should be undertaken towards the end of the winter. The lower lateral branches are then pruned to a height of 2 to 4 feet up the stem, so as to leave at least half of the crown. Depending upon the growth of the trees, they should from then on gradually be

pruned higher every year, so that the stems are eventually free from knots and branches up to a height of at least 25 to 30 feet from the ground or, if practical, even higher.

From the 5th year onwards it will be sufficient to have a crown of about one third of the total height. There is no need to fear that this high pruning will seriously interfere with the rate of growth. The initial results of some pruning experiments in a young *deltoides* plantation near Seven Oaks, Natal, so far show no marked difference in vigour and rate of increment between trees in which the living crown has been restricted to 1/3 of the total of the tree and those in which ½ of the crown has been left. A light pruning which removed only 25 per cent. of the crown each year has not resulted in a marked increase in diameter of the bole, but a considerable increase in diameter of the lower lateral branches and the butts of the trees.

Even with higher prunings the lateral branches of the crown often grow much more quickly than the leading shoot. If this undesirable competition with the leading shoot is not corrected in time, it will result in poorly shaped stems. The easiest way to prevent this is by trimming the crowns of young trees so as to give them a conical shape. This trimming is well known amongst French poplar growers under the name of "Emondage," and the author has put it into practice in young *deltoides* plantations with very good results. It can be done cheaply with secateurs, or on bigger trees, with branch cutters.

After each pruning a number of epicormic shoots will appear on the stems. These can easily be rubbed off by hand or knocked off with a stick while they are young and soft. If not done in time, the removal of these shoots will be more difficult and consequently more expensive.

Another important point is that only sharp tools should be used and that the branches should be cut off flush with the bark. If snags are left, the proper healing of the wounds will be delayed and decay is liable to enter the bole of the tree.

For high pruning Disston's pruning saw No. 111 can be recommended. This curved saw, which can easily be fitted on to a pole 17 to 20 feet long, has proved to be very efficient. Branches up to 1½ inches in diameter can easily be removed with this tool. In this way half the costs of pruning can be saved, for otherwise ladders which slow down the work very considerably, would have to be used.

One question remains to be dealt with, namely, whether all the trees should be pruned or whether the pruning should be restricted to a limited number of selected trees, which are likely to form the final stand. Since the final crop will probably consist of only 200 trees to the acre, why should 400 or 500 trees, most of which will be removed in the course of thinnings before they reach maturity, be pruned? Selection of stems for pruning may sound reasonable, but it cannot be recommended in practice for the following reasons. First of all, it makes very little difference in cost whether the natives have to prune every tree or whether they have to "search" for the selected ones, however clearly these may be marked. Secondly, if every tree is pruned there will be a much wider range of selection. Thirdly, as the thinnings from the seventh year onwards are marketable (see Table II), it is

obvious that the timber will not be acceptable to the match industry if it is full of branches and knots. Lastly, a partly pruned *deltoides* stand has a very untidy appearance.

Rate of Growth, Rotation and Yield

Very little accurate information has hitherto been available regarding the exact rate of growth of *P. deltoides* in this country. Investigations upon this aspect were started in 1937 by establishing a number of sample plots in several plantations in Natal, the Eastern Transvaal and the Cape. It will naturally take years before the results of these experiments become available but preliminary figures based on a number of accurate stem-analyses and actual measurements made during the past two years are reflected in Tables I, II and III.

TABLE I.

Height and D.B.H. over Age for Different Quality Sites.

Age years	QUALITY SITES					
	I		II		III	
	Minimum height feet	D.B.H. (over bark) inches	Height feet	D.B.H. (over bark) inches	Maximum height	D.B.H. (over bark) inches
1	5	0.5	3-5		3	
2	8	1.3	5-8	0.6	5	0.2
3	12	2.1	8-12	1.4	8	0.8
4	17	3.2	11-17	2.3	11	1.6
5	23	4.4	15-23	3.3	15	2.5
6	30	5.8	20-30	4.5	20	3.45
7	37	7.4	25-37	5.7	25	4.4
8	44	8.9	30-44	6.8	30	5.35
9	50	10.3	35-50	7.9	35	6.2
10	55	11.5	40-55	8.9	40	7.0
11	59	12.6	46-59	9.9	46	7.75
12	63	13.4	51-63	10.8	51	8.5
13	66	14.0	56-66	11.5	56	9.2
14	69	14.5	60-69	12.2	60	9.85
15	72	15.0	63-72	12.75	63	10.5
16	75	15.45	65-75	13.3	65	11.15
17	78	15.85	67-78	13.8	67	11.7
18	81	16.25	68-81	14.2	68	12.2
19	83	16.6	69-83	14.6	69	12.7
20	85	16.85	70-85	15.0	70	13.15
21	87	17.3	71-87	15.4	71	13.6
22	89	17.65	72-89	15.8	72	14.0
23	91	17.95	73-91	16.15	73	14.35
24	93	18.25	74-93	16.45	74	14.7
25	95	18.5	75-95	16.75	75	15.0

TABLE II.

INTERMEDIATE YIELD FROM THINNINGS (OVER 7" U.B.) ON FIRST QUALITY SITE.

At the end of year	Number of trees		Approximate timber yield		Number of trees left after thinning
	present	to be removed	cu. ft.	tons	
1	680	—	—	—	(650)
2	600-650	—	—	—	(600)
3	600	100	—	—	500
5	500	100	—	—	400
7	400	100	100	3	300
9	300	50	350	10	250
11	250	70	560	17	180

TABLE III.

FINAL YIELD OF TIMBER (OVER 7" U.B.) ON FIRST QUALITY SITE.

At the end of year	Mean D.B.H. (over bark) inches	Basal area cu. ft.	Length of timber, feet	Form-factor	Volume of tree cu. ft.	Number of trees	Volume per acre	
							cu. ft.	tons
8	8.9	0.4321	10	0.5	2.16	300	650	20
9	10.3	0.5787	14	0.5	4.05	300	1215	37
10	11.5	0.7214	18	0.5	6.49	300	1948	60
						250	1623	50
11	12.6	0.8660	22	0.5	9.52	250	2380	70
12	13.4*	0.9794	26	0.5	12.73	250	2970	90
						180	2292	70
13	14.0	1.0690	30	0.5	16.03	180	2886	85
14	14.5	1.1467	35	0.5	20.08	180	3614	110
15	15.0	1.2272	40	0.5	24.54	180	4418	135

A tree with a D.B.H. of 15 inches is considered to be the most suitable size for match wood. As can be seen from Table I, *P. deltoides* of such dimensions can be grown in 15 years on first quality sites.

As regards the figures for second and third quality sites, these are based on measurements up to the 15th year only. Beyond this age they are the result of theoretical calculation, as no trees older than 15 years have been measured. From a practical point of view the data for second and third quality sites are of no importance, as no one should establish a *P. deltoides* plantation for commercial purposes on sites which are not first quality.

The second rotation crop may grow even better than the first. In 1935 two acres of *P. deltoides* were clear-felled on a farm near Seven Oaks (Natal). The yield was 135 tons per acre, excluding

*If the thinning at the end of the 11th year is not carried out, the mean D.B.H. at the end of the 12th year will probably not exceed 13 inches.

timber under 8 inches in diameter. As the ground was rather overgrown, it was lightly cultivated. Wherever the old roots were injured during this process, young shoots came up in such abundance that a thinning became necessary during the first year. The growth was so vigorous that further thinnings have since been carried out annually. After four years there are 300 trees to the acre with an average height of 35 feet and an average D.B.H. of 5.3 inches. They have thus put on considerably more increment than would normally have been the case in the first rotation.

Character and Uses of the Timber

P. deltoides is a fast-growing tree and produces soft wood. The wood is odourless, fairly straight-grained and of a light colour. The wood peels very easily, takes glue, paint, wax and polish very well and holds nails excellently. It is not very highly inflammable and absorbs moisture rather quickly. Therefore it is liable to quick decay in contact with the soil or in damp places. Under cover, however, it stands well. As the green timber contains approximately 50 per cent. moisture it naturally shrinks and warps considerably, unless thoroughly seasoned and well stacked. Once properly seasoned, the warping during manufacture is negligible. The average weight of freshly felled *deltoides* timber is approximately 58 lbs. per cubic foot.

On account of these qualities the wood can be utilized for a good many purposes, namely match wood, brush wood, ply wood, box wood, packing cases and crates, wooden shoes (Holland), brake blocks, wood pulp, small household implements like wooden spoons, etc. and when thinly split, for wood wool, straw hats and many other useful articles.

In this country the biggest consumer is the match industry. Although the wood of *P. deltoides* is not equal in quality to Aspen (*Populus tremula*), it is a very good and useful substitute in the manufacture of matches. So far it has mainly been used for making match boxes, but there is every indication that the strength and quality of the timber increases with its age and that, when 15 years old, it will also be suitable for the manufacture of splints.

As the match industry in South Africa absorbs roughly 300,000 cu. ft. of poplar timber per annum for the manufacture of match boxes alone, the significance of *P. deltoides* in this country is obvious. A ready and profitable future market may safely be predicted for all well grown *deltoides* timber.

Injurious Insects

While there are many insects known in America and Europe which injure poplars either by feeding on the leavees or by boring into the timber, no such pests were known in South Africa until 1934. At that time it was discovered that some *deltoides* plantations in the Langkloof (Cape) were infested with a borer which proved to be the larva of *Teragra guttifera*. The life history of this insect is, unfortunately, not yet fully known. The female has a gray (dirty white) colour and the wingspread is approximately 1½ inches, the length of its body being just over 1 inch. The male is considerably smaller in size and is brown.



FIG. v.—Pruning *versus* non-pruning in three year old stand Pruning wounds are tarred against *Teragra guttifera*.



FIG. vi.—Twelve year old *P. deltoides* on farm Welverdiend, Piet Retief. Height 75 feet, D.B.H. 8.9 inches, 400 trees per acre. The 25 per cent. thinning shown is considerably delayed.

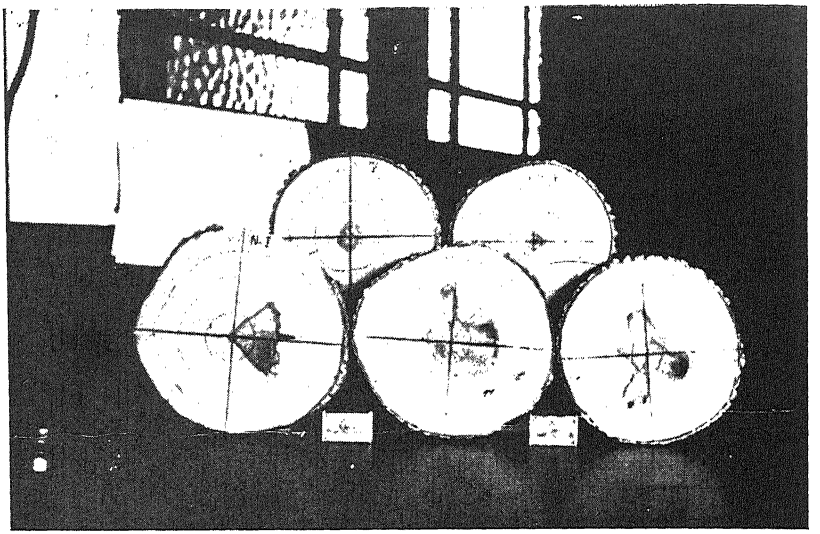


FIG. vii.—Cross-sections of five year old *P. deltoides* grown at the Umlaas Road, Water Works. Note the restriction of knots to a 3 inch core secured by live-pruning.

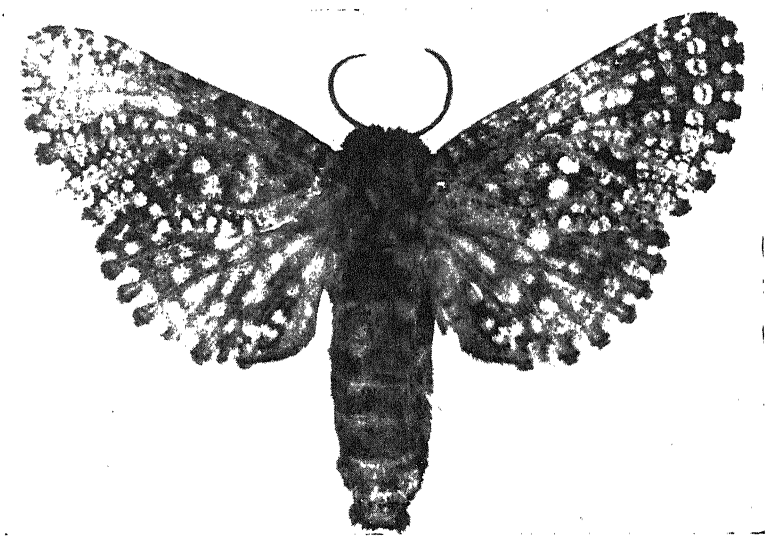


FIG. viii.—Moth of *Teragra guttifera* (enlarged about twice).

So far as it is known, *Teragra guttifera* deposits its eggs—the writer once counted 800 laid in one night by one moth—from October to the end of February on the bark at the base of the corky ridges or in wounds or scars. The young larvae, on hatching, feed on the upper layers of the cambium around the oviposition spots and while still very small start penetrating into the centre of the bole in a horizontal burrow. During the larval stage they seem to continue feeding on the cambium, using the tunnel as a safe retreat. Later they make a pupation chamber in the pith by boring upwards in the bole for 3 to 4 inches.

The larvae have black heads, strong jaws and at first a darkish, rather hairy, but later a yellowish and only slightly hairy body, with a number of regular dark spots or rings. They appear to pupate when they reach a length of approximately 1¼ inches and a diameter of about ¼ inch.

The presence of these borer larvae in a tree can be easily recognized by the accumulation of brown fras (digested wood) at the entrance of the tunnels on the bark, where it is held together by a few spun threads.

In the Langkloof, where *P. deltoides* grows rather slowly, the older wood seems to be too hard for this borer whose activity is, as a rule, limited to the softer upper portions of the stem and branches. It also appears that on vigorously growing trees a great number, if not most, of the young grubs are killed by the rapid flow of sap.

In Natal, where the trees grow more quickly and where the wood is somewhat softer than in the Cape, *Teragra guttifera* seems to attack the trees anywhere. Here borers have been found in trees from 2 to 10 inches in diameter, both in the trunk and in the upper portions of the trees.

Although these borers do not kill the affected trees, the damage they can do to match timber is considerable, especially when the trees are heavily infested. It is readily understandable that a tree riddled by 30 to 100 borers will not yield much match timber.

The most effective way of destroying the grubs is to dress all the oviposition spots with Stockholm or coal tar. A stiff brush fitted to a stick at right angles is very useful for painting these spots on the upper part of the stems and branches. It is not necessary to remove the fras before applying the tar. As *Teragra guttifera* seem to prefer places where soft tissues are available for feeding, it is advisable in infested areas to paint all pruning wounds or other scars with tar as a precautionary measure.

In *P. deltoides* plantations where this insect was found at the end of 1938, it has been successfully prevented from spreading further, if not entirely eradicated, by applying the above measures. In any case there is no reason to be alarmed by the presence of a few borers, as long as control measures are occasionally undertaken.

As far as silvicultural and biological methods of fighting *Teragra guttifera* are concerned, little is yet known. Experiments were started last year. Here it may be mentioned that the writer has discovered an Ichneumonid species and, in another case, some small parasitic flies, which emerged from pupae of *T. guttifera* collected in Langkloof plantations. Specimens of both were sent to the Chief Entomologist in Pretoria, and also to England, for identification. Whether these parasites

may be looked upon as helpful allies in the struggle against *T. guttifera* remains to be seen.

Eulophonotus myrmeleon was only recently discovered in willow trees, and in an adjoining *deltoides* plantation near Verulam on the North Coast of Natal. It has also been found in a number of *deltoides* trees near Port Shepstone. So far it has been observed only in fairly big trees. The caterpillars tunnel downwards in the wood near the base for a considerable distance in a vertical direction, going right down into the main roots. As it seems to restrict its activities on *P. deltoides* to the very lowest portion of the stem, it cannot do much damage to match timber. Tarring the entrances of the tunnels should also in this case be tried as a remedial measure.

In conclusion the writer wishes to express his indebtness to Mr. Tooke, the Forest Entomologist, for his ready and very helpful co-operation in the war against *Teragra guttifera*.

REFERENCES

(1) HUBBARD, C. S. "A Review of the Species of *Populus* Introduced into South Africa"; Forest Dept. Bull. No. 18: 1926.

(2) HOUTZAGERS, DR. G. "Het geslacht *Populus* in verband met zyn beteekenis voor de Houtteelt"; H. Veenman en Zonen—Wageningen, 1937.

AN INTERLOPER FROM BRAZIL

By M. H. SCOTT

(*Senior Forest Products Officer, Forest Products Institute.*)

Introduction

VERY frequently interesting timber specimens are received at the Forest Products Institute for identification and remarks and not many years ago a large furniture firm submitted two pieces of wood which very closely resembled our well known Black Stinkwood (*Ocotea bullata*).

When more closely examined, however, the pieces were found to have a decided and somewhat spicy odour by which they could easily be separated from the local timber. Several of the East African species of *Ocotea* were examined but apart from a rather similar structure the specimens did not agree closely with any of them.

At the time comparatively little significance was attached to the correct identification of the specimens as no particulars of their origin or the quantity available were known. When, however, a few years later a number of further samples were received, and it was learnt that the wood was being imported into South Africa in the solid and as a veneer a more determined effort was made to ascertain its specific identity. The common group name of the wood was disclosed as Canella and its particular name Embuia or Imbuia. Its country of origin was Brazil. Finally with the help of herbarium material the wood seems without doubt to have been identified as a species known as *Phoebe porosa*. In the meantime due to its similarity to *O. bullata* it also became known in the Union as "Imported Stinkwood" and considerable quantities were brought onto the market under that name.

It was thought that as the timber was available at comparatively very cheap rates in wide boards clear of defects, much damage would be done to the local trade in genuine South African Stinkwood. The immediate results, however, of the publicity given to this timber through letters and articles in the press seemed at least for a time to stimulate interest in the local product.

So many enquiries have since been received in connection with this wood and its relation to South African Stinkwood that it may be of interest to record what is known about it.

General Properties

It can at once be said that Imbuia is a wood of considerable merit. Like Stinkwood it varies considerably in graining, colour and weight. In fact the variation had given rise to the belief that at least two species were included under the common name. Although a wood anatomist cannot be too positive there is no evidence from a microscopic examination of the structure of the wood that this is the case, and in fact there is no greater variation than found in different specimens of genuine Stinkwood.

In the United States where the wood has been used for some time it is known as Brazilian Walnut which is apparently another attempt to popularise it by connecting its name with one of the best known furniture woods. It is a pity that so attractive a timber cannot be marketed by a distinctive name of its own rather than by depending on the reflected glory of some already well known timber.

Sawing Seasoning and Working

It has been difficult to obtain boards of Imbuia in a grass green condition but several pieces ranging in moisture content from twenty to thirty per cent. have been examined and from these it would appear to be a wood which saws up easily and cleanly both in the green and dry state. It is stated in the United States that the sawdust is irritating to some workers though no mention of this is recorded in this country.

The timber seasons well and although no doubt supplies received in this country have been specially selected for export, there are indications that the tree in general yields a product freer from blemishes than genuine Stinkwood. Pieces dried from moisture contents of 30 per cent. showed no corrugation, uneven shrinkage or surface checking. The figures recorded for shrinkage on these pieces were also comparatively low, averaging 3 and 6 per cent. for radial and tangential faces respectively, when dried to oven dry condition. This compares with 5 and 10 for Stinkwood. The lower shrinkage gives it a decided advantage, as in the manufacture of Stinkwood furniture it is necessary to make provision for almost twice the amount of seasonal change in dimension in all wide surfaces such as table tops and panels. Both woods, however, are apt to give considerable trouble unless properly seasoned.

Physical Properties

A general description of the wood is difficult on the account of the variation in figuring and colour. It is, however, usually brown in colour ranging from very light to dark chocolate sometimes beautifully variegated. Growth rings are obvious on most boards as darker lines and particularly distinct in many. Where the grain is straight the wood bears a close resemblance to teak (*Tectona grandis*) but is much finer in texture. Curly grained pieces though less common are usually included in most consignments and it is these especially that resemble Stinkwood. In most of the boards, especially darker ones, are small irregular splashes of black and the various shades of colour are beautifully blended.

The odour is brought out by moistening the wood or by working and is then strong and spicy. It is otherwise faint.

So far as the weight of Imbuia is concerned, of some twenty pieces from different sources tested a range of from 35 to 49 lb per cu. ft. air dry was found. The average was 42 which is approximately 5 lbs. lighter than Stinkwood. The lighter coloured wood was lighter in weight also.

The wood works up easily and takes a good polish. It is stated in America to be durable but no records of resistance to decay are available here yet, although samples are being interred at the termite testing station at Pienaars River, some forty miles north of Pretoria.

The imported wood is used almost exclusively for furniture although it would be equally useful for panelling and framing.

Comparison with Stinkwood

The following are the main points of difference which have been noted between Imbuia and genuine South African Stinkwood.

Stinkwood	Canella Imbuia
1. Characteristic but not very obvious rather foetid smell when worked. To accentuate smell chips may be shaken up in hot water.	1. Very strong, spicy resinous smell when worked or when surface is scraped. Also accentuated by shaking up chips in hot water.
2. Vessel margins clearly defined. Vessels less numerous and more uniform in size. Slightly larger on the whole.	2. Vessel margins poorly defined. Vessels more numerous with greater variation in size. Very slightly smaller on the average.
3. Oil cells absent, or nearly so on transverse section.	3. Oil cells abundant, showing up with coloured contents adjacent to vascular tissue.
4. Parenchyma sparse in irregular groups adjacent to vascular tissue.	4. Parenchyma pronounced and abundant. In larger or smaller irregular groups associated with vascular tissue and oil cells.
5. Tyloses typical.	5. Tyloses absent.
6. Rays usually deeper and narrower.	6. Rays shallower and wider.

It will be realised from what has been said that in many cases it is extremely difficult even for those acquainted with both woods to distinguish with certainty between Imbuia (*Phoebe porosa*) *and* Stinkwood (*Ocotea bullata*), but there is no other wood, however beautiful it may be, that can challenge our own Stinkwood in local esteem.

SOME LANGEBERG FORESTS

NOTES BY THUNBERG AND J. J. KOTZE

TO the average layman, the phrase "indigenous forest" means Knysna. For the slightly more initiated it conjures up a wider region, and his idea of forest country extends eastward, to include parts of the Eastern Cape Province and the Transkei, and perhaps the eastern slopes of the Drakensberg. Few realise, however, that those mossy-looking patches seen at a distance from train or main road, sheltering the watercourses of such ranges as the Winterhoek, the Witzenberg, the Drakenstein, and the Langeberg, in the Western Province of the Cape, are actually pocket forests, in which at one time thrived all the principle timber species of the Midlands. The Langeberg, stretching eastward from its conjunction near Robertson with the Naudesberg range, a spur of the Hex River Mountains, to merge into the Outeniquas near Mossel Bay, and made familiar to all South Africans through the paintings of its adoring Volschenck, is a region of inexhaustible surprises. In its countless involute folds are disclosed scenes domestic and wild: of delicate beauty and majestic grandeur. Here, between scree fringed mountain buttresses, the pocket forests clamber upwards to enjoy and protect the cascading streams that in winter time, at least, still issue from the Kranz scarred face. Certain of the more accessible of these, such as the Hermitage and Koloniesbos near Swellendam, are highly prized picnic spots.

The better known forests in the kloofs of this range have been exploited from time to time by successive governments, and by private enterprise for the establishment of neighbouring towns and erection of homesteads and farm buildings. From Thunberg it is learnt that from Grootvadersbosch, the largest of them, situated near Heidelberg, the Company's wagons a century and a half ago were removing only four loads of timber a year to Cape Town. In itself this is light exploitation of a 500 acre forest, in view of which it is not surprising to read that "The Forest" in 1772 "was very thick and lofty." For how long this rate of exploitation was maintained and whether it had not at some earlier date been heavily exceeded, however, is not known. Nor is Thunberg's criterion of "thickness." Quite another picture is, however, drawn by a traveller-contemporary of Thunberg's. Dr. E. C. Molsbergen, who visited Grootvadersbosch on the 11th December, 1776, two years after Thunberg's last visit, reported in his "Reizen in Zuid-Afrika in de Hollandse Tijd" that "Dit bosch strekt zig een uur of 2 langs het gebergte uyt, maar het timmerhout is er byna geheel uytgehakt, zodat men niet dan kromme en slegte boomen ziet." If Thunberg was not very explicit about the quality of the forest as it existed in his day, he at least left a fairly circumstantial account of its composition. The following notes on, or connected with, the forest are extracted from "Travels in Europe, Africa, and Asia Performed between the Years 1770 and 1779," by

Charles Peter Thunberg, M.D., Professor of Botany at the University of Upsala, first English edition, published about 1782.

1772 On the 18th we passed *Puspas Valley* and *Rivier,* and arrived at *Zwellendam,* the residence of one of the company's land-drosts, whose jurisdiction extends over all the interior part of the country that lies beyond this spot, and whose office is in some respect, though not absolutely, similar to that of the governor of a province.

The acrid berries of the *fagara capensis* were used both here and in other parts of the country in the colic.

After dining with the landd-rost, M. MENTZ, by whom we were received with the greatest hospitality, we continued our journey across the broad river, known by the name of *Buffeljagt's Rivier,* to one of the company's posts, called *Riet Valley* (Reed Valley)†, where we stayed several days, to arrange the collections we had made, and to repair our wretched carriage, which had been shattered to pieces by the strong and mountainous roads; a cart so small, old, and crazy, that probably nobody, either before or after us, can boast of having made, in such a vehicle, so long and dangerous a journey into this mountainous country.

Vol. i. pp. 167/8.

Not far from this farm of the company's which particularly furnishes it with large timber, in a cleft in the mountains, stood a large wood, called *Grootvader's Bosch,* or Grandfather's Wood. To this we made an excursion, with a view of becoming acquainted with the indigenous trees of Africa. After passing by a farm-house called *Rietkeul,* we arrived at *Duyvenhoek's Rivier,* at a spot which had obtained the name of *Helle* (or Hell)* on account of the mountain at this part forming a very deep valley. The forest was very thick and lofty, but unfortunately the trees at this season had neither blossom nor fruit on them, to satisfy my curiosity.

A species of pepper (*piper capense*) that was found in abundance in the wood here, was called by the country people *staart-pepper* (or tail-pepper) and used by them as a spice.

We left our cart at the company's post, and in the place of it procured a large waggon tilted over with sailcloth, together with ten fresh oxen, to continue our intended expedition to the Coast of Caffraria.

Vol. i. pp. 169/70.

As we proceeded farther‡ on the 20th and 21st, we passed several farms in our way to the company's post at *Riet Valley.*

While we baited here, we paid another visit to *Grootvader's bosch,* where various sorts of trees are felled for the use of the company. I hoped now to find several trees in blossom; but the season was not yet far enough advanced.

---

*Possibly identifiable with the Kruisrivier Gorge.
†Established 1734.
‡On the party's return.

The *Calodendrum,* however, was then in blossom, the honeyed juice of which I perceived beautiful butterflies sucking, without my being able to reach either the one or the other. But by the help of my gun, which I loaded with small shot, and fired in among the trees, I got some branches with blossoms on them.

Vol. i. p. 213.

1773 From hence we went to *Zwellendam,* and afterwards to the Company's post, near *Buffeljagt rivier,* where we rested a few days.

The colony of *Zwellendam,* which is subject to its own peculiar landrost, had been founded about thirty years before. It took its name from Mr. ZWELLINGREBEL, who was at that time vice-governor, or *Secundu's* (*Tweede*) at the Cape. The first landrost here was RENIUS, the second ORACK, who was still alive but had resigned, and the third was the present landrost, whose name is MENTZ.

The Company's post had at first been established, for the sake of protecting those colonists who had settled on this spot, and farther up in the country, in order to cultivate the land and rear cattle. It was therefore at first laid out as a fort, and provided with seven men and a corporal; but, after the country came to be more inhabited and the Hottentots quitted it, all these fortifications were found to be quite unnecessary and superfluous. Instead of this a grazing farm is now established here, and the soldiers are employed in the wood, called *Grootvaders bosch,* or (Grand-father's Wood) in felling, for the use of the Company, different sorts of timber for joiners work, &c. of which timber a waggon load is sent to the Cape every three months, besides what the people of the colony, in order to assist in maintaining them, are allowed to carry up and sell themselves.

Vol. ii. pp. 40/1.

1774 The following days, continuing our route, we arrived at Riet-valley, one of the Company's posts, where we remained a few days to rest ourselves, and particularly for the sake of paying another visit to Groot Vaders bosch, or (*Grandfather's-wood*) and seeing if the different kinds of trees there were come into blossom, as we had already got pretty far into January, and consequently the summer was farther advanced than it had been at any time before, when we had visited this wood.

On the *14th of January* accordingly, we went thither, but were not more successful now than we had been before with respect to finding the trees in blossom, much less with fruit on them. Some of them however were on the point of budding.

Here were at this time, for the Company's account, two wood-men, who, after felling the trees, dragged them to such spots from whence they might be taken up and put into waggons. The trees were chiefly got out of the wood by oxen, by means of a cord fastened round the body of the tree; as no vehicle of any kind could possibly be used there.

As I had no hopes of ever visiting this place again, I made a point now of collecting and laying up to dry branches with leaves of every species of tree, and at the same time of becoming perfectly acquainted with the use they made in this country of each species.

The uses of the different sorts of trees that grew in and round about the wood, were as follows;

Black iron wood, (*Zwarte Yzerhout, Gardenia Rothmannia*) is hard and strong: it is used for axel trees and the poles of waggons.

Yellowwood (*Geelhout, Ilex crocea*) is of a yellow colour, almost like box, of a close texture, and handosme. It is used for planks and beams in the construction of houses, for tables, doors, cupboards, window-frames, and butter-churns.

Camassie wood (*Camassie-hout*), is merely a shrub, and consequently produces small pieces only, which serve for veneering, and to form borders on furniture, as likewise for making planes and other fine and delicate tools. This is one of the finest and heaviest kinds of wood.

The wood of the Red pear tree (*Roode peer*) is used for making the bodies, under and upper axle-trees, and the lower parts, of waggons.

The Bucku tree (*Bucku hout, Olea Capensis*) is the best wood for making wheels of waggons.

The Red alder (*Roode Else, Cunonia capensis*) is likewise very proper for making waggon wheels, the naves of wheels and chairs.

The Ash (*Essenhout, Essenboom, Houtniquas Essen, Ekebergia capensis*) is a large tree, hard and of a close texture, and is used for making tools and implements of various kinds.

Of the *Stinkhout* there are two sorts, the white and the brown. The brown is very beautiful, being of a dark colour with bright streaks and dashes, much like walnut-tree. Of this are made clothes-presses, desks, chairs, tables and other costly kinds of furniture. When it is first cut down it stinks, a circumstance from which it has obtained its present name; but, in process of time, when it has been exposed to the open air, the disagreeable odour vanishes.

The wood of the Olive tree, (*Olyvehout, Olea Europaea*) is very heavy, and of a brown colour. I have often seen at the farmers' houses chairs made of this wood, which felt very heavy in the hand. This strong wood is also used in the construction of mills.

Wild Catjepiring (*Gardenia Thunbergia*) is a hard and strong kind of wood, and on this account used for clubs.

Witte Essen (or white ash) is used for planks, for waggon-racks, and for the boards in waggons, for boards for shoe-makers to cut leather on, and sometimes for cupboards.

Zwart-bast (*Royena villosa*) is used for the bodies of waggons, and to make yokes for draught-oxen.

Keurhout (*Sophora capensis*) is used for wheels and the bodies of waggons.

The Almond tree, (*Amandelhout*) is used for the heels of shoes, and for shoe-maker's lasts.

The *Assagay tree* (*Assagay boom, Curtisia faginea*) is used for the poles of waggons, and as shafts for the Hottentots' javelins.

Dorn-hout (*Mimosa nilotica*) is used for *Lock-shoes*, to put under waggon wheels, as likewise for the bows of yokes for draught oxen and for making charcoal.

The Waageboom (*Protea grandiflora*) for fuel and making charcoal.

The Kreupelboom (*Protea speciosa*). The bark is used by tanners for dressing and tanning leather.

The Leepelboom is made into spoons and wooden bowls.

The largest trees in African woods, as well in this as in others, were the following: the Geelhout (*Ilex crocea*), the bucku (*Olea capensis*), the Tarchonanthus camphoratus, and arboreus, the Roode-else (*Cunonia capensis*) and the Wite-else, the Stinkhout, the Assagayhout (*Curtisia*) the wild Chestnut (*wilde Castanien, brabejum stellatum*) the wild Fig tree (*wilde Vygeboom, Ficus capensis*) the Keureboom (*Sophora capensis*) the Mimosa nilotica and the Esse-boom (*Ekebergia capensis*).

On the hills grew the *Ornithogalum altissimum*, which was now in full blossom, an decorated the plain with its long and crowded spikes of flowers. It was said to be very common every fourth year, and, in the intervening years, hardly to be seen.

Vol. ii. pp. 108/12.

Thunberg's reference to yellowwood under the botanical name of *Ilex crocea* is surprising. His description of it, and the uses he assigns to it, agree with the generally entertained conception of *Podocarpus latifolius*. The latter species does occur in most of the forest patches of the Western Province, and Mr. Kotze, in the notes that conclude this article, includes it amongst the predominant species found in a forest situated a very short distance away from Grootvatersbosch, making no mention whatever of *Cassine*. *Cassine crocea* (*Elaeodendron croceum*) timber is not yellow as stated by Thunberg, but distinctly red. It seems clear that Thunberg has gone astray here, but how could it have happened? It is conceivable that his note on the tree concerned may have been jotted down in the field under the heading "yellowwood," without using a botanical name; but even so, he was collector as well as systematist, and when he came to elaborate his notes at leisure, his self-collected specimens would surely have put him on the right track. An authority on indigenous timbers, in the Division of Forestry, who is himself convinced of Thunberg's error, on being asked how the mistake could have occurred, offered what is possibly the only solution by suggesting that Thunberg was, after all, just human!

Other apparently anomalous names used by Thunberg in his notes are not wrong in the above sense, and have precision to-day provided authority for them is cited, as has been done in the following list kindly furnished by Mr. H. B. Gilliland, lecturer in botany at Witwatersrand University:—

Brabeium stellatum Thunb. = *B. stellatifolium* Linn.

Calodendrum (*capense*) (Linn. f.) Thunb. = *Dictamus capense* Linn. f. = *Calodendron* of Sim.

Gardenia Rothmannia Thunb. = *Gardenia capensis* (Thunb.)

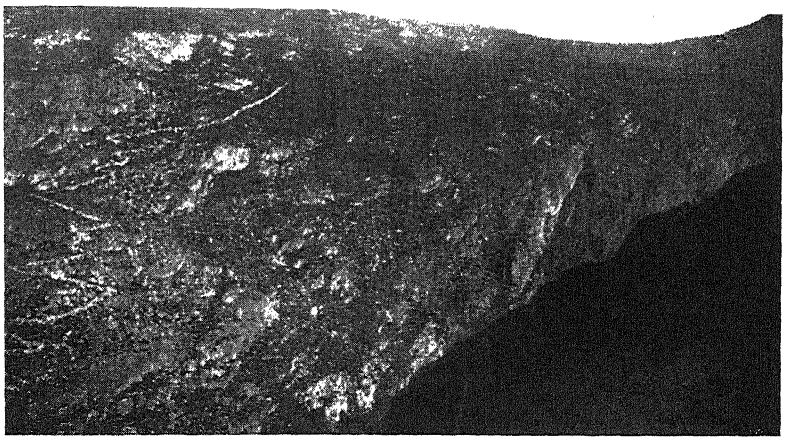


FIG. i.—Kruis Rivier gorge showing path followed by Mr. Kotze's party.

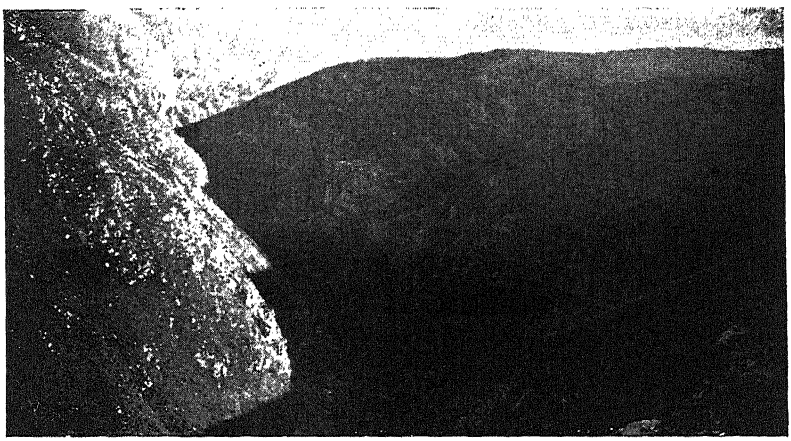


FIG. ii.—Kruis Rivier george. Another view.



FIG. iii.—Stinkwood trees and tree ferns in Boosmansbos.

Druce. = *Rothmannia capensis* Thunb. Zwarte Izerhout, used as a common name by Thunberg, is more appropriately used for *Olea laurifolia.*

Ilex crocea Thunb. = *Cassine crocea* (Thunb.) Presl. = *Elaeodendron croceum* (Thunb.) DC. [Probably used in error for *Podocarpus latifolius.* See above. *Ed.*]

Mimosa nilotica Thunb. non Linn. = *Acacia karroo* Hayne.

Olea europea Thunb. non Linn. = *Olea africana* Miller = *Olea verrucosa* Link. Of this tree Sim states "A tree so like the European olive that where the two are growing alongside in cultivation it is difficult to find a distinction except in the size of the fruit."

Ornithogalum altissimum Linn. f. = *Urnigea altissimum* (Linn. f.) Baker.

Royena villosa Thunb. non Linn. = *Royena lucida* Linn.

Sophora capensis Linn. = *Virgilia capensis* (Linn.) Lam.

Tarchonanthus arboreus = ? *Brachylaena ellipticus* (Thunb.) Less. = *T. ellipticus* Thunb.

Common names used alone by Thunberg have the following botanical equivalents:—

Camassie-hout: *Gonioma kamassi* E. Mey.

Stink-hout: *Ocotea bullata* (Burch.) E. Mey. [The two kinds of timber, white and brown, remarked on by Thunberg, derive from trees of precisely the same botanical identity. *Ed.*]

Stinkwood: See Stink-hout.

Roode peer: *Scolopia Mundtii* (Arn.) Warb.

White ash: *Platylophus trifoliatus* (Linn. f.) Don. The more usual name for this species is witte els.

Wite-else: See white ash.

Witte essen: See white ash.

The importance of these notes by Thunberg is stressed by Mr. Gilliland in the following note:—

> Thunberg's collections on his travels from 1770 to 1779 were amongst the earliest to be made in South Africa and, occurring as they did so soon after Linnaeus had laid, in 1773, the foundations of Systematic Botany, an unusually large proportion of specimens collected by him were among the first scientific records of a species. Thunberg brought back his specimens to Upsala and we find that they were described either by Linnaeus's son (Linn. f.) or Thunberg himself, if they had not been described from previous collections by Linnaeus. Thunberg succeeded in due course to the Chair of Botany at Upsala University.

Although to-day the hand of man has deprived Grootvadersbosch of any claim to the condition of a virgin forest there are in its near neighbourhood three smaller forests so closely hemmed in by untraversable gorges that little or no wood could ever have been removed from them. They are to-day probably nearer the virgin state than Grootvadersbosch was at the time of Thunberg's visits. Thunberg left no pictorial representation of Grootvadersbosch, but by the courtesy of Mr. J. J. Kotze, Conservator of Forests, Cape Town, to whom we are furthermore indebted for the notes that follow, we are able to

publish the accompanying photographs of Boosmansbos and Braambos, situated in the adjoining Tradouwsberg Forest Reserve.

On the 9th July of this year, accompanied by the District Forest Officer, Mr. J. H. Keet, Forester Brown of Swellendam, and Forester Ross of Grootvadersbosch, I left Grootvadersbosch Forest Station, and, proceeding along the footpath which leaves the northern boundary of the Eastern Section of that Reserve over Mr. Moodie's property towards the south western boundary of the Tradouwsberg Forest Reserve, negotiated the very steep gorge of the Kruis Rivier by means of a zig-zag on either side, and entered Tradouwsberg near beacon D, as shown on the accompanying map.

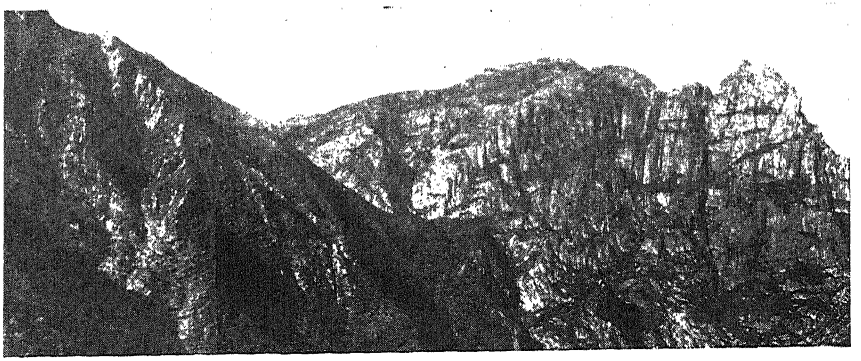
This formidable gorge is an absolute barrier to any possibility of road transport. Some idea of its nature can be obtained from photographs 1 and 2. From the gorge the path proceeds northwards up another zig-zag, and then veers eastwards, following valleys and ridges. At the northern end of belt No. 3, the first view of the precipitous slopes and the gorge of the Noukrans River with its tributaries in impressive kloofs is obtained. From here can be seen also portion of the smaller Braambos forest on the distant mountain slopes.

Proceeding due east, the first glimpse of Boosmansbos is secured from a ridge comparatively close to it.

This is the forest *par excellence* in which the Stinkwood occurs. It is situated for the most part at the bottom of the gorge formed by the Noukrans river. This river has its source in the deep kloofs immediately below Lemoenshoek Trigonometrical Beacon, 5371 feet above mean sea level, and the main stream runs from North to South. It is along the upper reaches of this main stream and on its lower precipitous eastern "banks" that the Boesmansbos occurs. The river then continues its course southwards through a most imposing and precipitous gorge.

Realising that a series of photographs would convey a far better idea of the type of country in which the forest occurs than any pen pictures I could give, I endeavoured to secure them. This was by no means easy but the panorama shown in photograph No. 4, taken from a ridge fairly close to the gorge and from which the last descent is made to the forest, is of interest. It will, I think, convey some idea of the very broken nature of the country. The bottom of the gorge and the forest is not visible. It is difficult to estimate its extent, but I would place it in the vicinity of, say, 250 acres.

I have been in many forests in the Union—in the Terblanz Forest at Gouna, which I understood was more or less virgin, in other parts of the best Knysna and Storms River forests, in the Schwartzwald forest at Wolfridge, the Pirie and Isidinge and the Amatola forests, in the mountain and coastal forests of the Transkei, including Tonti, in the Natal forests, in the forests further north along the Drakensberg in the eastern Transvaal, notably at Mariepskop, in the Woodbush and Zoutpansberg forests, but nowhere have I ever had the great thrill and privilege of



e, showing higher portion of Boosmansbos.



FIG. vii.—Section cut from windfallen stinkwood tree in Boosmansbos. Mean diameter 3 ft. 10 inches.

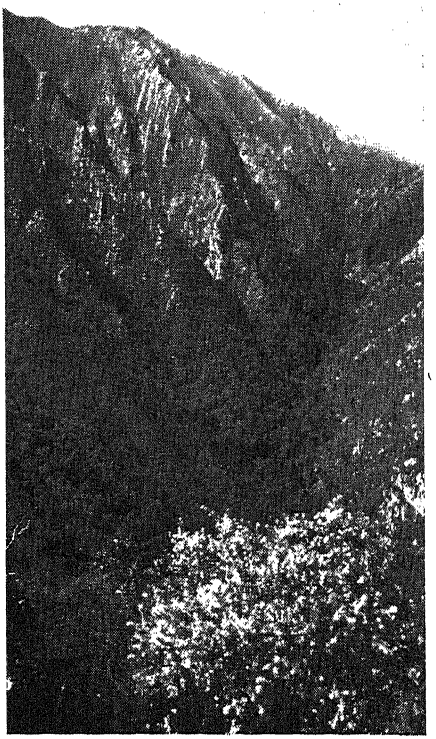


FIG. viii.—Braambos, with Buchu (*Barosma serratifolia*) in foreground.

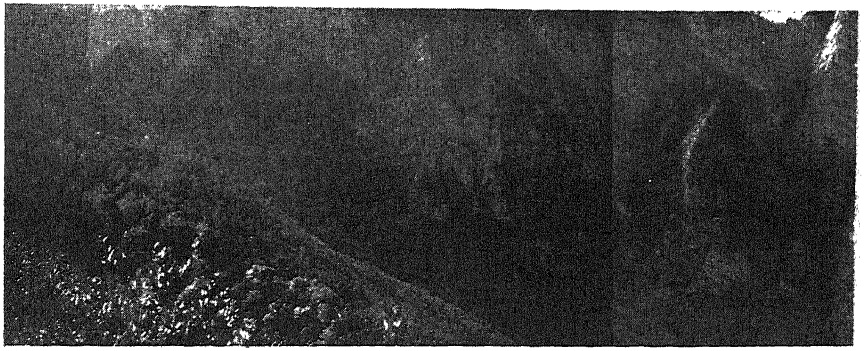


FIG. iv.—Part of Tradouwsberg Forest Rese

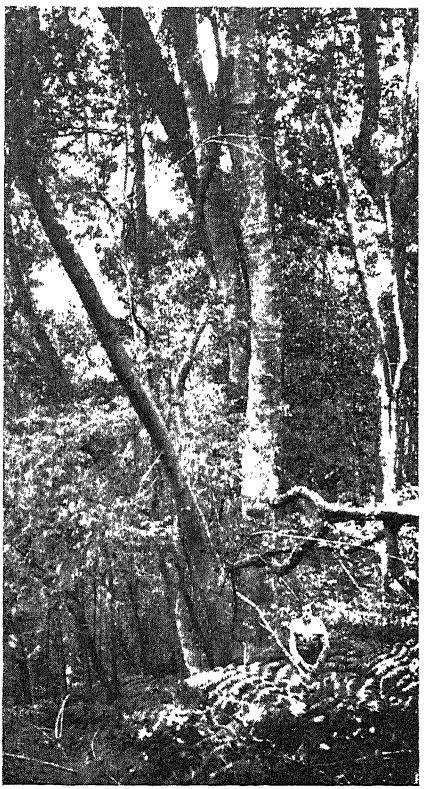


FIG. v.—Stinkwood (*Ocotea bullata*) in Boosmansbos.

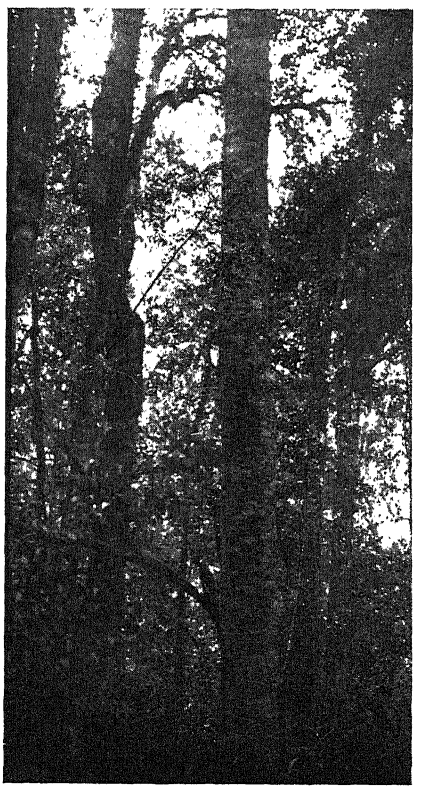


FIG. vi.—Rooi-els (*Cunonia capensis*) in Boosmansbos.

beholding a truly virgin forest, undesecrated by the hand of Man. At last I stood, far distant from civilisation in the heart of the Langeberg, in such a forest. It was with a feeling of reverence and awe that one moved about amidst one of Nature's wonders.

There are no giant Yellowwoods such as one sees the remnants of at Deepwalls, at Storms River and at Tonti, in fact, I noted only one *Podocarpus latifolius* of a d.b.h. of 14 inches, but what a feast of Stinkwoods, Red Els, White Els and Keur! The latter occur, strangely enough, right inside the forest and have clear boles with diameters at breast height up to 3 ft.*

Owing to the time it takes to reach the forest and the fact that we had to be back that night at Grootvadersbosch, I had only a very limited time in the forest itself. We made the most of that time, however, and explored the forest along the river bed for a short distance.

The predominant species were judged to be as follows in the order given:—

1. *Cunonia capensis* (Red Els) ... ... Up to 6 ft. in diameter
2. *Ocotea bullata* (Stinkwood) ... ,, ,, 4 ,, ,, ,,
3. *Platylophus trifoliatus* (White Els) ,, ,, 6 ,, ,, ,,
4. *Virgilia capensis* (Keur) ... ... ,, ,, 3 ,, ,, ,,
5. Various (*Ilex mitis, Rapanea melanophleos, Pterocelastris tricuspidatus, Podocarpus latifolius,* etc.) of small stature.

The portion of the forest visited varies from the Wet or Moist, with *Hemitelia capensis* (Tree ferns) and *Blechnum capensis,* to the Medium-moist type.

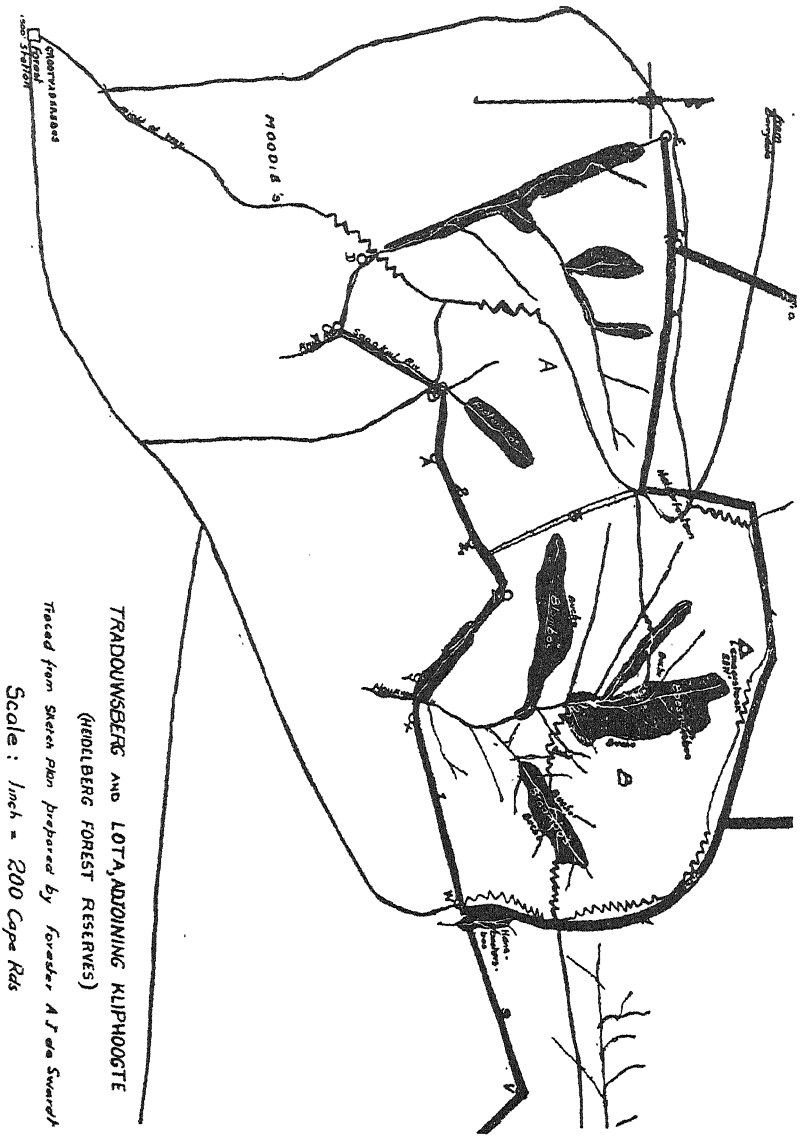
The chief interest lay in the magnificent specimens of Stinkwood and Red Els. The old rough-barked Stinkwood is now, for the most part, a memory in the minds of the older Knysna Foresters. They should come to Boosmansbos to refresh that memory. There they are up to 4 ft. in diameter. Regeneration, too, is profuse and ready to take the place of the mother trees.

I should emphasize, however, that it is probable that the quality of the forest falls off considerably as one proceeds away from the stream-bed and up the slopes. Photographs 3 and 5 to 7 give some idea of the portion of the forest visited. They give the impression, however, that the forest is more open than it really is.

It has been ascertained by Mr. J. H. Keet, District Forest Officer, Bredasdorp, that Boosmansbos takes its name from a coloured man who inhabited a cave in the Forest some sixty or more years ago, and subsisted by robbing bees nests and selling buchu and firewood. Signs of his depredations are still evident in the charred remains of some twenty hollow stinkwood stems that lie scattered about the forest floor.

---

*It is suggested by Professor J. F. V. Phillips, to whom these notes were shown, that this rather militates against the claim of intactness for this forest. He points out that Keur is a successional species, not a climax.



Some Langeberg Forests.

AFRIKAANSE BOSBOOMNAME

DEUR C. L. WICHT
(*Bosnavorsingsbeambte, Jonkershoek, Stellenbosch.*)

BOSBEAMBTES in Suid-Afrika noem graag ons bome by hulle populaire of gewone name. In wetenskaplike publikasies word hierdie name meestal naas die wetenskaplike of Latynse aangegee. Een rede waarom hierdie populaire name so algemeen in gebruik is, is dat hulle vir die publiek verstaanbaarder is as die vreemde Latynse name. 'n Ander rede, wat seker nie minder belangryk is nie, is dat die name dikwels so treffend die een of ander uitstaande kenmerk van die boom beskrywe. 'n Persoon wat ons bome wil leer ken, sal dus wyslik handel as hy ook met hulle populaire name vertroud raak.

'n Populaire boomnaam kan soms vir bosbeambtes en plantkundiges 'n waardevolle wenk wees by die wetenskaplike bepaling van 'n boomsoort. Goeie plantkundige boeke sorg dus gewoonlik dat die populaire plantname so volledig moontlik aangegee word. Bekende wetenskaplike boeke oor Suid-Afrikaanse plante, waarvan nie een in Afrikaans geskrywe is nie, gee talryke sulke name van bome en ander plante aan. Die meeste Afrikaanse name wat in hierdie publikasies aangegee word, verskyn egter nog in die Nederlandse vorm. Baie daarvan is verkeerd gespel omdat die skrywers nie Afrikaans of Nederlands goed geken het nie.

'n Volledige lys van Afrikaanse boomname sal seker ook taalkundige waarde hê. In hierdie verband is besonderhede oor die afleiding en buitengewone plaaslike gebruik van name veral interessant. Dit is mooi om te weet dat b.v. *Kiepersol*—die naam van 'n bekende saambreelvormige boom—'n verbastering van 'n Portugese woord vir 'n saambreel is. Hierdie boom word soms ook *Sambreelboom* genoem.

In die reël ken Afrikaners hulle bome maar sleg. Miskien sal dit hulle aanmoedig om met die bome grondiger kennis te maak as dié aan hulle voorgestel word in hulle eie taal in plaas van in die vreemde Latyn. *Platylophus trifoliatus* en *Rapanea melanophleos* is genoeg om iedereen af te skrik, maar met *Wit-els* en *Boekenhout* kan die gewoonste mens maats maak.

Afrikaanse boomname behoort dikwels aan die ongekunstelde volkstaal, en daar is gevolglik onder hierdie name verskeie wat 'n preutse persoon seker as onfatsoenlik sal beskou. Dat hulle egter sprekend is, is nie aan te twyfel nie.

Die meeste van ons populaire boomname is Afrikaans, maar byna elke inheemse boom in Kaffergebiede het ook 'n Kaffernaam, en sommige van hierdie name soos *Tambotie* en *Oemsimbeet* is reeds in Engels en Afrikaans opgeneem. Die aantal Engelse populaire boomname is kleiner.

Hiermee word 'n poging gemaak om 'n lys van Afrikaanse boomname, wat botanies sowel as taalkundig juis is, uit verskillende bronne, saam te stel. In die lys wat hier volg, gee ek die Latynse naam naas die gewone boomnaam, en daar sal verder enkele besonderhede oor die boom en sy naam bygevoeg word. Die lys maak egter geen

aanspraak op volledigheid nie, en dit sal hoog op prys gestel word as belangstellendes verder bydraes wil stuur. Latynse name en hulle Afrikaanse ekwivalente word in 'n aparte lys alfabeties aangeheg.

Die boomname in die lys sal slegs op *—boom* eindig wanneer dit in die spreektaal gebruiklik is b.v. *Anaboom* en *Akkerboom*. Ander name soos *Geelhout, Apiesdoring* en *Bobbejaanappel* word in die spreektaal dikwels sonder *—boom* gebruik, maar dit moet natuurlik bygevoeg word as daar onsekerheid bestaan of die boom of b.v. die hout, of die doring, of die appel bedoel word.

Die illustrasies is van oorspronklike kiekies wat in Jonkershoek en omgewing geneem is.

Graag wil ek my innige dank betuig aan professor J. J. Smith, die Redakteur van die Afrikaanse Woordeboek wat nou in voorbereiding is, vir die informasie verleen in verband met die oorsprong van 'n aantal Afrikaanse boomname en ook vir wenke in verband met die taalvorm van die lys. Mnr. E. K. Marsh, Bosnavorsingsbeambte, Pretoria, wil ek graag bedank vir sy hulp by die bepaling van die nuutste Latynse name van die bome en vir baie ander waardevolle aanbevelings vir die verbetering van die lys.

AAPKOP. *Acacia Gerrardii* Bth. (fam. *Leguminosae*). S.* Engelse Doring; Rooibas; Swarthaak; Rooihaak; Rooidoring; Oudoring; Swarthaakdoring; Rooihaakdoring. 'n Bosveldboom met 'n plat kroon.

AAPKOS. Sien AAPSEKOS.

AAPSEKOS. *Gardenia Rothmannia* L. (fam. *Rubiaceae*). S. Aapkos; Apieskos; Bobbejaanappel; Bobbejaanappelbos; Kershout; Wildekatjiepiering; Kalbas; Swarthout. 'n Boom van gemiddelde grootte wat veral in woude voorkom van Swellendam tot in Transvaal. Dit dra 'n ronde vrug tot twee duim lank, wat sag word as dit ryp is en dan deur voëls en ape gevreet word.

AASVOËLBESSIES. *Maurocenia frangularia* Mill. (fam. *Celastraceae*). 'n Struik of boompie van kusstreke in die suidwestelike Kaapprovincie. Dit dra 'n eetbare steenvrug so groot soos 'n kersie.

ABIEKWAS-GEELHOUT. *Tamarix articulata* Vahl. (fam. *Tamaricaceae*). 'n Boompie wat langs riviere in Namakwaland en in centrale dele van die Karoo voorkom. Die naam ABIEKWA is Hottentots.

AFRIKAANSE BUKSBOOM. Sien BUIG-MY-NIE.

AKACIA. Australiese *Acacia*-bome en die Noord-Amerikaanse *Robinia pseudacacia* L. (fam. *Leguminosae*), wat in die Unie aangekweek word.

AKKERBOOM. Sien EIKEBOOM.

ANABOOM. *Acacia albida* Del. (fam. *Leguminosae*). S. Apiesdoring. 'n Groot boom wat in dele met parkvegetasie tot in Middel-Afrika voorkom. Peule word aan vee gevoer.

APIESDORING. (1) *Acacia Galpini* Burtt Davy. (fam. *Leguminosae*). 'n Groot Bosveldboom.

(2) *Acacia Burkei* Bth. (fam. *Leguminosae*). S. Haakdoring; Knoppiesdoring. Boom van die Hoë Bosveld.

(3) *Acacia delagoensis* Harms. (fam. *Leguminosae*). 'n Boom van die Transvaalse Laeveld. Sie ook ANABOOM.

APIESKOS. Sien AAPSEKOS.

ASGAAI. Sien ASGAAIHOUT.

ASGAAIHOUT. *Curtisia faginea* Ait. (fam. *Cornaceae*). S. Asgaai. 'n Groot boom wat voorkom in woude van die Kaap tot in die trope. Dit lewer waardevolle hout, wat veral vir vervaardiging van speke gebruik word. Die naam dui aan dat die hout vroeër vir die vervaardiging van hefte vir asgaaie gebruik is. Vandag is hierdie gebruik egter nie meer bekend nie.

ATLAS-CEDER. *Cedrus atlantica* Manetti, (fam. *Pinaceae*). Dit is die CEDERBOOM van Noord-Afrika.

*S. = Synoniem.

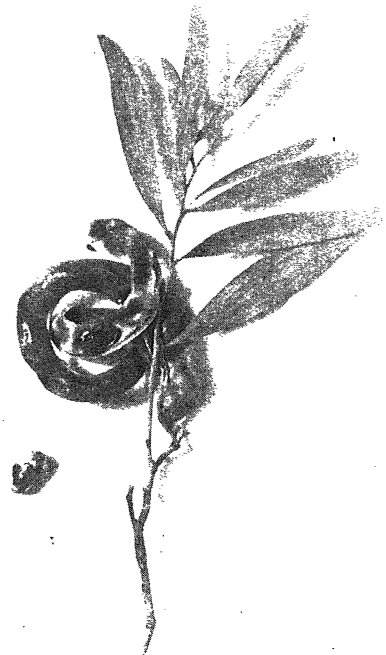




Olienhout. *Olea verrucosa* Link.
Top: The tree.
Bottom: Foliage and fruit.



Keur—*Virgilia oroboides* Salter.
(*S. Virgilia capensis* Lam.)



Rooikrans—*Acacia cyclopis* A. Cunn.

BAAKHOUT. *Greyia Sutherlandii* Hook et Harv. (fam. *Greyiaceae*). 'n Klein boompie met sierlike rooi blomme wat langs die Drakensberge in Natal en Transvaal voorkom. Die boompie groei dikwels op rotse en lyk dan soos 'n baak of baken.

BAKHOUT. *Lannea discolor* Engl. (fam. *Anacardiaceae*). S. Dikbas; Bastermaroela. 'n Boompie van die oostelike Transvaal.

BAOBAB. Sien KREMETARTBOOM.

BASBOOM. *Acacia decurrens* Willd.; *A. mollissima* Willd. (fam. *Leguminosae*). S. Wattel. Bome van gemiddelde grootte uit Australië, wat van Natal tot in Transvaal vir die produksie van looibas aangekweek word. Ander *Acacia*-soorte waarvan die bas ook vir hierdie doel gebruik word, word ook soms BASBOME genoem.

BASTER-ESSENHOUT. Sien ESSENHOUT.

BASTER-GEELHOUT. Sien OUTENIEKWA-GEELHOUT.

BASTER-KAMEELDORING. Sien HAAK-EN-STEEK.

BASTER-KAREE. *Rhus Gueinzii* Sond. (fam. *Anacardiaceae*). S. Taaibos. 'n Struik of boompie wat van Natal tot in oostelike Transvaal voorkom.

BASTER-MAROELA. Sien BAKHOUT.

BASTER-OLIENHOUT. Sien SALIE.

BASTER-PERDEPIS. *Hippobromus pauciflorus* Radlk. (fam. *Sapindaceae*). 'n Boompie wat van die Kaap tot in Transvaal voorkom. Sien ook PERDEPIS.

BASTER-SAFFRAAN. Sien KOFFIEPEER.

BASTER-YSTERHOUT. *Olea foveolata* E. Mey. (fam. *Oleaceae*). 'n Boompie wat van die Kaap tot in Transvaal voorkom.

BERGBAS. *Osyris abyssinica* Hochst. (fam. *Santalaceae*). S. Pruimbas; Jakhalspruimbessies; Jakhalspruim; Bloupruim; Blaarbas. 'n Struik wat voorkom op berge van die Kaap tot in Transvaal. Die bas, takkies en blare lewer looistof. Die vrug lyk soos 'n pruimpie.

BERGCYPRES. Sien SAPREE.

BERGHARDEPEER. Sien ROOIBESSIE.

BERGPRUIM. *Pappea capensis* Eckl. (fam. *Sapindaceae*). S. Kaambessie; Pruimbessie; Wildepruim; Oliepitte; Wilde-amandel; Noupitjie; Noupitte. 'n Boompie wat veral in die Oostelike Provincie maar ook in Natal en Transvaal voorkom. Vrug lyk soos 'n pruimpie en is eetbaar. Olie, wat vir medicyne gebruik word, word uit die pitte gepers.

BERGSAFFRAAN. Sien ROOIPEER.

BERGSAPREE Sien SAPREE.

BEUK. *Fagus sylvaticus* L. (fam. *Fagaceae*). S. Beukeboom; Boek; Boekenhout. Bekende Europese boom. Word selde in die Unie aangekweek. Ingevoerde artikels soos stoele, handvatsels van borsels, ens., is dikwels van beukenhout vervaardig. Die naam is dieselfde as ons woord *boek* : die oudste geskrifte van die Germaanse volke was op boekenhoutsafies. (Eng. Beech).

BEUKEBOOM. Sien BEUK.

BEUKENHOUT. Sien BEUK en BOEKENHOUT.

BITTER-AMANDEL. *Pygeum africanum* Hook. (fam. *Rosaceae*). S. Nuwehout; Rooistinkhout. 'n Groot boom wat voorkom van Knysna tot in die trope. Vrug soos 'n klein kersie, maar baie bitter.

BITTERBAS. *Bersama Tysoniana* Oliv.; B. Swinnyi Phill.; B. Stayneri Phill. (fam. *Melianthaceae*). Bome wat in die Transkei en Natal voorkom. Die bas smaak bitter.

BITTERBLAAR. *Brachylaena elliptica* Less. (fam. *Compositate*). S. Salie. 'n Struik of boompie van die Oostelike Provincie en Natal. 'n Afkooksel van die blare, wat bitter smaak, word gebruik om mee te gorrel in gevalle van seerkeel.

BLAARBAS. Sien BERGBAS.

BLINKBLAAR. L. *Rhamnus prinoides* L'Her. (fam. *Rhamnaceae*). 'n Struik of boompie met gladde, blink blare wat dwarsdeur die Unie voorkom. Sien ook BLINKBLAAR-WAG-'N-BIETJIE en DOPPERKIAAT.

BLINKBLAAR-WAG-'N-BIETJIE. *Zizyphus mucronata* Willd. (fam. *Rhamnaceae*). S. Blinkblaar; Buffelsdoring; Haakdoring; Wag-'n-bietjie; Katdoring. 'n Doringagtige struik of boom wat veral noord van die Oranjerivier voorkom. Die blare is donkergroen en blink.

BLOEKOMBOOM. *Eucalyptus globulus* Labill. (fam. *Myrtaceae*). S. Blougomboom. 'n Baie groot Australiese boom wat in die Unie aangekweek word. Die jong blare is blouerig van kleur.

BLOMBOS. Sien DROLPEER.

BLOUBOS. *Royena pallens* Thunb. (fam. *Ebenaceae*). S. Swartbos (in die Kalahari). 'n Struik of boompie wat van die Kaap tot in die trope voorkom. Sien ook VAALBOS.

BLOUGOMBOOM. Sien BLOEKOMBOOM.

BLOUHAAK. Sien HAAKDORING.

BLOUPRUIM. Sien BERGBAS.

BOBBEJAANAPPEL. Sien AAPSEKOS.

BOBBEJAANAPPELBOS. Sien AAPSEKOS.

BOBBEJAANKERS. Sien SAPREE.

BOEK. Sien BEUK.

BOEKENHOUT. *Rapanea melanophleos* (L) E. Mey. (fam. *Myrsinaceae*). S. Witboekenhout. 'n Waardevolle meubelhoutboom, wat voorkom in woude van die Kaap tot in Transvaal. Die hout lyk, oppervlakkig beskou, na Europese Beukenhout, maar is baie mooier. Sien ook BOSBOEKENHOUT; BREËBLAARBOEKENHOUT; ROOIBOEKENHOUT; SWARTBOEKENHOUT en BEUK.

BOERBOON. (1) *Schotia speciosa* Jacq. (fam. *Leguminosae*). 'n Doringagtige struik of boompie van die Oostelike Provincie, Transkei en Natal. Dit dra groot peulvrugte, wat aanleiding gegee het tot die naam.
(2) *Schotia brachypetala* Sond. (fam. *Leguminosae*). S. Hottentotsboerboon; Huilboerboon; Huilbos. 'n Meubelhoutboom van die Transvaalse Bosveld en Natal. Sien ook BOSBOERBOON en TRANSVAALSE BOERBOON.

BOESMANSGIF. Sien GIFBOOM.

BOESMANSTEE. *Catha edulis* Forsk. (fam. *Celastraceae*). S. Spelonke-tee. 'n Boompie in woude van die Oostelike Provincie tot in die Transvaal. 'n Tee word van die blare voorberei wat vir hoes, asthma en ander borssiektes gebruik word.

BOKDROL. *Canthium ventosum* L. (fam. *Rubiaceae*). S. Skaapdrolletjie. 'n Struik of boom in woude van die Kaap tot in Natal. Die naam dui op die vrugte nadat hulle uitgedroog en ingekrimp van die boom geval het.

BOOG. *Croton gratissimus* Bruch. (fam. *Euphorbiaceae*). 'n Boompie van karoïede veld en die Bosveld.

BORRIEHOUT. Sien LEMOENHOUT.

BOSBOEKENHOUT. *Pittosporum viridiflorum* Sims. (fam. *Pittosporaceae*). S. Rooiboekenhout; Kasuur. 'n Boom of boompie wat van Knysna tot in Natal en Transvaal voorkom. Sien ook BOEKENHOUT.

BOSBOERBOON. *Schotia latifolia* Jacq. (fam. *Leguminosae*). S. Boerboon. Die Boerboon wat veral in bosse of woude voorkom. Sien ook BOERBOON.

BOSGANNA. Sien BOSTAAIBOS.

BOSGHWARRIE. *Euclea lanceolata* E. Mey. (fam. *Ebenaceae*). S. Ghwarrie. 'n Struik of boompie wat van die Kaap tot in Transvaal in woude voorkom.

BOSTAAIBOS. *Rhus Legatii* Schonl. (fam. *Anacardiaceae*). S. Kieriehout; Westelike Essenhout; Bosganna. 'n Boom van gemiddelde grootte wat van die Kaap tot in Transvaal voorkom. Dit is die Taaibos wat in die woude of bosse groei. Die hout word deur naturelle gebruik om pype en kieries uit te sny.

BOSVAALBOS. Sien VAALBOS.

BOSVADERLANDSWILG. Sien ROOIBLAD.

BOSVELDBOEKENHOUT. Sien SWARTBOEKENHOUT.

BOSVY. Sien WILDEVYEBOOM.

BOTTERKLAPPER. *Strychnos pungens* Solered. (fam. *Loganiaceae*). 'n Boompie van Zoeloeland en die oostelike Transvaal met eetbare vrugte. Die groot ronde vrug, wat aan 'n klapper laat dink, bevat 'n botteragtige pulp. Sien ook KIERIEKLAPPER; SUURKLAPPER en ROOIBOS.

BREËBLAARBOEKENHOUT. *Faurea speciosa* Welw. (fam. *Proteaceae*). 'n Struik of boompie van die oostelike Transvaal.

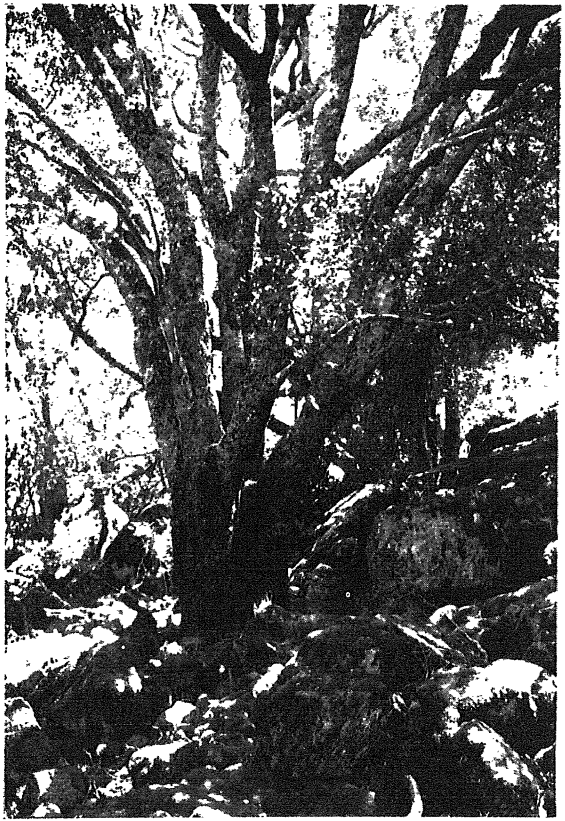
BREËRIVIER-GEELHOUT. *Podocarpus elongatus* L'Her. ex Pers. (fam. *Podocarpaceae*). 'n Boom wat langs riviere in die winterreënvaldele van die Kaapprovincie voorkom.

BROSDORING. Sien OUDORING.

BUFFELSBAL. Sien WILDEKATJIEPIERING.

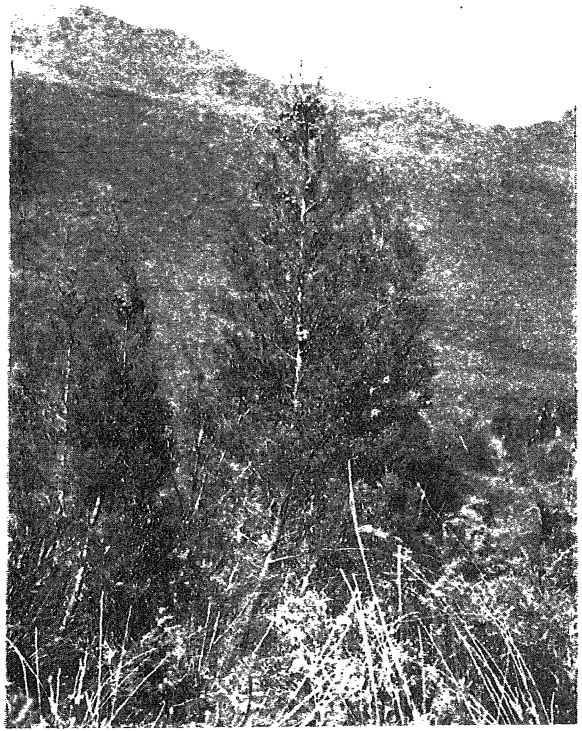
BUFFELSDORING. Sien BLINKBLAAR-WAG-'N-BIETJIE.

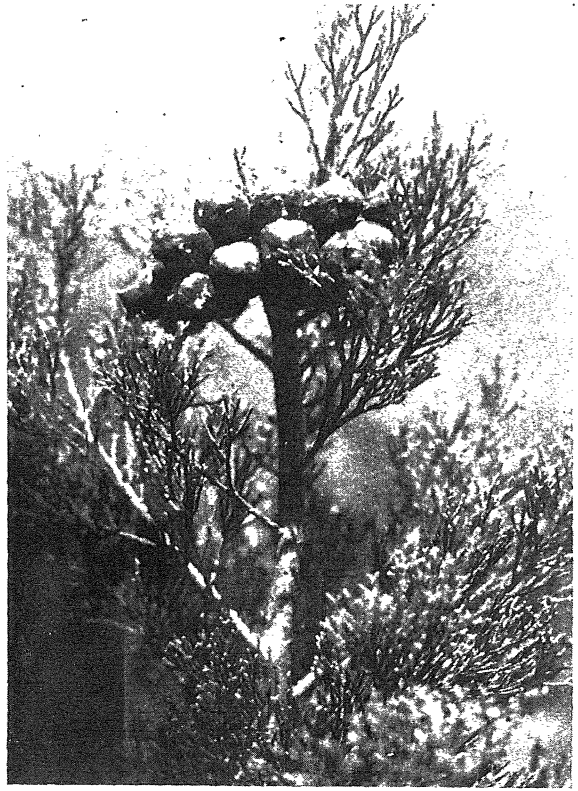
BUFFELSHORING. *Burchellia bubalina* Benth. and Hook.; S. *Burchellia capensis* R.Br. (fam. *Rubiaceae*). S. Wildegranaat. 'n Struik of boompie wat in woude van Swellendam tot in Natal en Transvaal voorkom. Blomme is helderrooi soos dié van granaat en vrug behou die gekrulde blomkelk wat aan die horings van 'n buffel laat dink.





Rooibessie—*Olinia cymosa* Thunb.





Sapree—*Widdringtonia cupressoides* Endl.

BUIG-MY-NIE. *Buxus Macowani* Oliv. (fam. *Buxaceae*). S. Afrikaanse Buksboom. 'n Boompie wat langs die kus in die Oostelike Provincie groei. Die hout word uitgevoer na Europa en daar vir dieselfde doeleindes as bukshout (*Buxus sempervirens* L.) gebruik.

CEDER VAN LIBANON. *Cedrus libanitica* Trew. (fam. *Pinaceae*). Die groot Cederbome van die Libanonberge waarvan in die Bybel melding gemaak word.

CEDERBOOM. Alle soorte van die geslag *Cedrus* (fam. *Pinaceae*). Groot keëldraende bome van die noordelike halfrond. Sien ook CLANWILLIAM-CEDER; ATLAS-CEDER; DEODAR en CEDER VAN LIBANON.

CHEMNEN. Sien RHODESIESE MAHONIEBOOM.

CLANWILLIAM-CEDER. *Widdringtonia juniperoides* Endl. (fam. *Cupressaceae*). S. Cederboom. 'n Groot boom met 'n dik stam wat in die Cederberge naby Clanwilliam voorkom. Dit lewer die waardevolle cederhout.

CYPRES. Alle soorte van die geslag *Cupressus* (fam. *Cupressaceae*). Bome van die noordelike halfrond wat baie in die Unie aangekweek word. Sien ook SAPREE en KERKHOF-CYPRES.

DANEBOOM. Sien DENNEBOOM.

DEN. Sien DENNEBOOM.

DENNEBOOM. Alle soorte van die geslag *Pinus* (fam. *Pinaceae*). S. Daneboom; Den. Groot keël-draende bome van die noordelike halfrond waarvan sommige in die Unie aangeplant word. Sien ook INSIGNIS; KANARIESE DENNEBOOM; PATULA-DEN en SPAR-DEN.

DEODAR. *Cedrus deodara* Loud. (fam. *Pinaceae*). Die cederboom van die Himalajagebergte. Dit word veral in die somereënvaldele van die Unie aangekweek.

DEURMEKAAR. *Ehretia rigida* (Thunb.) Druce. (fam. *Borraginaceae*). S. Stamperhout. 'n Boompie wat van die Oostelike Provincie tot in Natal en Transvaal voorkom.

DIKBAS. Sien BAKHOUT en DROLPEER.

DOPPERKIAAT. *Pterocarpus rotundifolius* Druce. (fam. *Leguminosae*). S. Blinkblaar. 'n Bosveldboom. Sien ook HUILBOS.

DORINGBOOM. (1) Inheemse soorte van die geslag *Acacia* (fam. *Leguminosae*). Die meeste inheemse *Acacia*-bome dra groot dorings en word dus doringbome genoem.

(2) *Acacia karroo* Hayne. (fam. *Leguminosae*). S. Karoodoring; Soetdoring; Mimosa; Witdoring; Pendoring. 'n Wydverspreide boom van die somerreënvaldele van die Unie, met groot, reguit, wit dorings.

DORINGPEER. *Scolopia Zeyheri* Szysz. (fam. *Flacourtiaceae*). S. Hoenderspoor; Wolwedoring. 'n Doringagtige boom wat voorkom van Knysna tot in Natal. Dit lewer 'n baie harde hout.

DRAGIES. Sien DROOG-MY-KEEL.

DROLPEER. *Dombeya rotundifolia*. Harv. (fam. *Sterculiaceae*). S. Blombos; Dikbas. 'n Blaarwisselende boom wat veral in die oostelike en noordelike Transvaal en Natal voorkom.

DROOG-MY-KEEL. *Scutia myrtina* Kurz.; S. *Scutia indica* Brogn. (fam. *Rhamnaceae*). S. Wag-'n-bietjie; Katdoring; Dragies. 'n Doringagtige struik, klimop of boompie, wat van die Kaap tot in Natal voorkom. Die vrug het 'n frank smaak—vandaar die naam DROOG-MY-KEEL—maar word tog deur kinders geëet.

DUPRESKNOP. Sien SAPREE.

EBBEHOUT. Sien EBBENHOUTBOOM.

EBBENHOUTBOOM. (1) Baie soorte van die familie *Ebenaceae*, veral soorte van die geslag *Diospyros*. S. Ebbehout; Ebbehoutboom. Bome met pikswart kernhout. Ebbenhout van *Diospyros Ebenum* Koen., uit Ceylon en Suid-Indië besit die hoogste waarde.

(2) *Euclea pseudebenus* E. Mey. (fam. *Ebenaceae*). S. Swart-ebbenhout; Ebbehout. 'n Boom langs riviere in Namakwaland en Suidwes-Afrika. Die kernhout is swart.

EGOSSA-ROOIPEER. *Phyllanthus discoideus* Müll. Arg. (fam. *Euphorbiaceae*). 'n Boom wat van die Egossawoud, noord-oos van Port St. Johns, tot in die trope voorkom.

EIK. Sien EIKEBOOM.

EIKEBOOM. *Quercus robur* L. (fam. *Fagaceae*). S. Eik; Akkerboom. 'n Groot boom van Wes-Europa. Goed bekend as sierboom langs strate, veral in die Westelike Provincie. Vrug bekend as akker.

ELS. Alle soorte van die geslag *Alnus* (fam. *Betulaceae*). Bome uit Noord-Amerika, Europa en Asië wat langs water groei (Eng. Alder). Sien ook ROOI-ELS en WIT-ELS.

ENGELSE DORING. Sien AAPKOP en OUDORING.

ENGELSMANSDORING. *Acacia Rehmanniana* Schinz. (fam. *Leguminosae*). 'n Bosveldboompie.

ENKELDORING. Sien OUDORING.

ES. Alle soorte van die geslag *Fraxinus* (fam. *Oleaceae*). S. Esboom. Bekende uitheemse timmerhoutbome van die noordelike halfrond wat in die Unie aangekweek word. (Eng. Ash).

ESBOOM. Sien ES.

ESSENHOUT. (1) *Ekebergia capensis* Sparrm. (fam. *Meliaceae*). 'n Groot bosboom wat voorkom van Knysna tot in Transvaal. Die blare lyk, oppervlakkig beskou, soos dié van *Fraxinus*. Dit is die ESSENHOUT van die Kaapprovincie. (2) *Trichilia emetica* Vahl. (fam. *Meliaceae*). S. Rooi-essenhout; Natalse Mahonie; Baster-essenhout. 'n Boom wat langs die hange van die Drakensberge in Natal en in die oostelike en noordelike Transvaal voorkom. Dit is die ESSENHOUT van Pondoland, Natal en Transvaal.

GEELHOUT. Alle soorte van die geslag *Podocarpus* (fam. *Podocarpaceae*). Groot waardevolle bosbome wat lig(geel)-gekleurde timmerhout lewer. Sien ook ABIEKWAS-GEELHOUT; OUTENIEKWA-GEELHOUT; REGTE GEELHOUT; BREËRIVIER-GEELHOUT; HENKEL-GEELHOUT en VAALBOS.

GHOEBOEBESSIE. Sien KOBOBESSIE.

GHOEBOONTJIE. Sien WILDE-AMANDEL.

GHWARRIE Sien BOSGHWARRIE.

GIFBOOM. (1) *Acokanthera venenata* G. Don. (fam. *Apocynaceae*). 'n Boompie wat in alle beboste dele van die Unie voorkom. Die boom is giftig. (2) *Toxicodendron capense* Thunb. (fam. *Euphorbiaceae*). S. Wolweboontjie; Wolwegif; Boesmansgif. 'n Giftige boompie van die Westelike Provincie. Die sade is vroeër gebruik om „wolwe" of hyenas te vergif.

GIFDORING. Sien LEMOENDORING.

GOMBOOM. Alle soorte van die geslag *Eucalyptus* (fam. *Myrtaceae*). Groot Australiese bome wat in die Unie aangekweek word.

GOUDBOOM. Sien KREUPELHOUT.

GREINHOUT. Sien KIAAT.

GROOTBLAAR. *Cordia abyssinica* R.Br. (fam. *Boraginaceae*). 'n Boom van die noordelike Transvaal met groot blare.

GROOTBLAAR-YSTERHOUT. Sien WILDE-APPEL.

GROOT-WITGATBOOM. Sien WITGAT.

GRYSAPPELBOOM. *Parinarium mobola* Oliv. (fam. *Rosaceae*). S. Mobola; Mobola-pruim. 'n Bosveldboom met 'n lekkerruikende, eetbare vrug, wat 'n bietjie soos 'n appel lyk.

HAAKDORING. *Acacia detinens* Burch. (fam. *Leguminosae*). S. Swarthaak, Hakiesdoring; Wynruit; Wag-'n-bietjie; Blouhaak. 'n Struik of soms 'n boompie met 'n plat kroon, wat van die Kalahari noordwaarts voorkom. Sien ook BLINKBLAAR-WAG-'N-BIETJIE.

HAAK-EN-STEEK. *Acacia litakunensis* Burch. (fam. *Leguminosae*). S. Basterkameeldoring; Withaak. 'n Klein boompie wat van Griekwaland-Wes noordwaarts voorkom. Dit dra reguit en krom dorings.

HAKIESDORING. Sien HAAKDORING.

HARDEKOOL. *Combretum imberbe* Wawra., var. *Pelersii* Engl. (fam. *Combretaceae*). S. Loodhout. 'n Mooi, groot Bosveldboom met wit bas. Die hout is baie swaar.

HARDEPEER. *Strychnos Henningsii* Gilg. (fam. *Loganiaceae*). 'n Groot boom wat voorkom van die Amatolas tot in Transvaal. Sien ook ROOIBESSIE en KOFFIEPEER.

HARPUIS. *Heeria paniculosa* O. Ktye. (fam. *Anacardiaceae*). S. Rapuis; Respies. 'n Boompie van Natal en die oostelike Transvaal. Die name RAPUIS en RESPIES is verbasteringe van HARPUIS.

HENKEL-GEELHOUT. *Podocarpus Henkelii* Stapf. (fam. *Podocarpaceae*). 'n Groot timmerhoutboom wat van die Oostelike Provincie tot in Transvaal voorkom. Dit het lang, smal, hangende blare.

HOENDERSPOOR. Sien DORINGPEER.

HOPHOUT. *Trema guineensis* Ficalho (fam. *Ulmaceae*). 'n Blaarwisselende boom wat in woude in die oostelike Transvaal voorkom.



Vaderlandsrooihout—*Kiggelaria africana* L.



Sybas—*Gymnosporia acuminata Szysz.*





Wildekatjiepiering—*Gardenia Thunbergia* L.

HOTTENTOTSAMANDEL. Sien WILDE-AMANDEL.
HOTTENTOTSBOERBOON. Sien BOERBOON.
HUILBOERBOON. Sien HUILBOS en BOERBOON.
HUILBOOM. Sien HUILBOS.
HUILBOS. *Peltophorum africanum* Sond. (fam. *Leguminosae*). S. Huilboom; Dopperkiaat; Huilboerboon. 'n Bosveldboom van gemiddelde grootte. Waar die stam beseer word, word druppels soos trane gevorm. Sien ook BOERBOON.
IEP. Alle soorte van die geslag *Ulmus*. (fam. *Ulmaceae*). S. olm. Bekende uitheemse bome van die noordelike halfrond waarvan sommige in die Unie as sierbome aangekweek word.
INSIGNIS. *Pinus insignis* Doug.; S. *Pinus radiata* Don. (fam. *Pinaceae*). 'n Vinnig-groeiende denneboom van Kalifornië, Amerika, wat veral in die winterreënvaldele van die Unie aangekweek word.
ITALIAANSE POPULIER. *Populus nigra* var. *Italica* Du Roi. (fam. *Salicaceae*). 'n Hoë, smal boom wat as sierboom en windskerm in baie dele van die Unie aangekweek word.
JAKARANDA. *Jacaranda mimosaefolia* D. Don.; S. *Jacaranda ovalifolia* R.Br. (fam. *Bignoniaceae*). Bekende sierboom met pragtige blou blomme wat langs strate, veral in Pretoria, aangekweek word.
JAKHALSBESSIE. *Diospyros mespiliformis* Hochst. (fam. *Ebenaceae*). 'n Boom van die noordelike Transvaal en Zoeloeland. Vrug is eetbaar. Sien ook WITMELKHOUT.
JAKHALSPRUIM. Sien BERGBAS.
JAKHALSPRUIMBESSIES. Sien BERGBAS.
JARRA. *Eucalyptus marginata* Smith (fam. *Myrtaceae*). 'n Groot boom uit Australië wat die bekende ingevoerde Jarrahout lewer.
JENEWERBOOM. *Juniperus communis* L. (fam. *Cupressaceae*). 'n Boompie van Europa en Asië. Die vrugte word gebruik by die vervaardiging van die drank jenewer.
KAAMBESSIE. Sien BERGPRUIM.
KAFFERBOOM. *Erythrina caffra* Thunb. (fam. *Leguminosae*). 'n Groot blaarwisselende boom met pragtige rooi blomme, wat van Uitenhage noordooswaarts tot in die trope voorkom. Sien ook NATALSE KAFFERBOOM.
KAFFERPRUIM. *Harpephyllum caffrum* Bernh. (fam. *Anacardiaceae*). S. Suurpruim. 'n Boom wat van die Oostelike Provincie tot in Transvaal en verder noordwaarts voorkom. Dit dra 'n eetbare vrug wat soos 'n pruimpie lyk. Die boom word dikwels as sierboom aangekweek.
KAFFER-WAG-'N-BIETJIE. Sien KATDORING.
KAFFER-YSTERHOUT. Sien OEMSIMBEET.
KALANDER. Sien OUTENIEKWA-GEELHOUT.
KALANDER-GEELHOUT. Sien OUTENIEKWA-GEELHOUT.
KALBAS. Sien AAPSEKOS.
KAMASSIE. *Gonioma Camassi* (Ecklon) E. Mey; S. *Gonioma Kamassi* E. Mey. (fam. *Apocynaceae*). 'n Boompie wat ooswaarts tot by Oos-Londen voorkom. Die harde, geel hout word saam met die van BUIG-MY-NIE uitgevoer as BUKSHOUT. KAMASSIE is 'n Hottentotse naam.
KAMDEBO-STINKHOUT. *Celtis Kraussiana* Bernh. (fam. *Ulmaceae*). S. Witstinkhout; Witgatboom; Onbekende boom. 'n Groot blaarwisselende boom wat van die Kaap tot in Transvaal en verder noordwaarts tot in Abessynië voorkom. Groei dikwels op Dolomietkoppies naby die ingang van grotte waar die wit rotse gesien kan word; vandaar die naam WITGATBOOM. Die boom is genoem na die streek Kamdebo, oorspronklik 'n Hottentotse naam. Sien ook WITGAT.
KAMEELDORING. *Acacia giraffae* Burch. (fam. *Leguminosae*). 'n Groot boom met sambreelvormige kroon, wat noord van die Oranjerivier langs die Kalahari voorkom. Sien ook HAAK-EN-STEEK en VAALKAMEELDORING.
KANARIESE DENNEBOOM. *Pinus canariensis*. Ch. Smith (fam. *Pinaceae*). 'n Denneboom van die Kanariese Eilande wat in die Unie aangekweek word.
KANFERBOOM. *Cinnamomum Camphora* T. Nees. et Eberm. (fam. *Lauraceae*). 'n Pragtige boom wat dikwels in die Unie as sierboom aangekweek word. Dit is afkomstig uit die Ooste, en kanfer word uit die hout en blare gedistilleer. Sien ook KANFERHOUT.
KANFERBOS. Sien KANFERHOUT.
KANFERHOUT. *Tarchonanthus camphoratus*. L. (fam. *Compositae*). S. Supree; Sieriehout; Vaalbos; Wilde-salie; Veldvaalbos; Kanferbos. 'n Struik of

boompie wat van die Kaap tot in Abessynië voorkom. Die blare ruik na kanfer en is vaal van kleur. Hulle word deur Mohammedane gekou, en die boompie word SIERIEHOUT genoem na 'n oosterse plant (Sirih) wat ook gekou word.

KANNABOS. *Dais cotinifolia* L. (fam. *Thymelaeaceae*). 'n Struik of boompie wat van die Oostelike Provincie tot in Natal en Transvaal voorkom.

KAREE. Sien KAREEBOOM.

KAREEBOOM. *Rhus lancea* L. (fam. *Anacardiaceae*). S. Karee; Rooikaree; Soetkaree. 'n Boompie met afhangende takke wat langs riviere in die droër dele van die Unie voorkom. Karee is die Hottentotse naam van die boom. Sien ook TAAIBOS en BASTER-KAREE.

KAROODORING. Sien DORINGBOOM.

KARRI. *Eucalyptus diversicolor* F. v. M. (fam. *Myrtaceae*). 'n Groot Australiese gomboom wat as timmerhoutboom in die Kaapprovincie aangekweek word.

KASTAIING. *Castanea sativa* Mill. (fam.*Fagaceae*). 'n Boom van die noordelike halfrond wat veral vir die vrugte—kastaiings—aangekweek word. Sien ook WILDEKASTAIING.

KASUUR. Sien BOSBOEKENHOUT.

KATDORING. *Acacia caffra* Willd. (fam.*Leguminosae*). S. Kaffer-wag-'n-bietjie. 'n Doringboompie wat van die Oostelike Provincie noordooswaarts voorkom. Sien ook DROOG-MY-KEEL en BLINKBLAAR-WAG-'N-BIETJIE.

KATJIEPIERING Sien WILDEKATJIEPIERING.

KEI-APPEL. *Dovyalis caffra* Warb. (fam. *Flacourtiaceae*). 'n Boompie van die Oostelike Provincie en Natal wat in baie dele van die Unie as heiningplant aangekweek word. Die ronde geel vrug is eetbaar en word ook vir konfyt gebruik. Genoem na die Hottentotse riviernaam Kei.

KERKHOF-CYPRES. *Cupressus sempervirens* var. *stricta* Ait. (fam. *Cupressaceae*). 'n Smal, regop boompie van Suid-Europa wat in die Unie veral op begraafplase aangekweek word.

KERSHOUT. *Pterocelastrus tricuspidatus* Sond. (fam.*Celastraceae*). 'n Boom wat van die Kaap tot in Natal voorkom. Sien ook AAPSEKOS.

KEUR. *Virgilia oroboides* Salter.; S. *Virgilia capensis* Lam. (fam. *Leguminosae*). S. Keurtjie; Keurboom. 'n Sierlike boompie wat van die Kaap tot by Port Elizabeth voorkom. Sien ook TRANSVAALSE KEUR.

KEURBOOM. Sien KEUR.

KEURTJIE. Sien KEUR.

KIAAT. (1) *Pterocarpus angolensis* DC. (fam. *Leguminosae*). S. Transvaalse Kiaat; Greinhout; Lakboom; Lakhout. 'n Waardevolle meubelhoutboom wat in die oostelike Bosveld en verder noord tot in die trope voorkom.

(2) *Strychnos decussata* (Pappe.) Gilg.; *S. Strychnos Atherstonei* Harv. (fam. *Loganiaceae*). 'n Boom wat van die Oostelike Provincie tot in Natal voorkom. Sien ook HUILBOS.

KIEPERSOL. *Cussonia spicata* Thunb. (fam. *Araliaceae*). S. Sambreelboom; Nooiensboom; Waaiboom. 'n Boom van gemiddelde grootte wat van Swellendam tot in Middel-Afrika voorkom. Die boom is sambreelvormig en KIEPERSOL is 'n verbastering van 'n Portugese woord vir 'n sambreel.

KIERIEHOUT. Sien BOSTAAIBOS.

KIERIEKLAPPER. *Combretum rhodesiacum* Bkr. (fam. *Combretaceae*). S. Steelboom. 'n Boompie van die oostelike Transvaal. Sien ook BOTTERKLAPPER; SUURKLAPPER en ROOIBOS.

KINDERBESSIE. Sien NOTSING.

KININEBOOM. *Rauwolfia caffra* Sond. (fam. *Apocynaceae*). 'n Boom wat van die Transkei tot in Transvaal voorkom. Die bas smaak bitter en sou die eienskappe van kinine besit. Die egte ingevoerde kinine word deur boomsoorte van die geslag *Cinchona* gelewer.

KLIPDORING. Sien ROOIPEER.

KLIP-ELS. *Canthium Mundtiana* Cham. et Schlecht.; S. *Plectronia Mundtiana* Pappe (fam. *Rubiaceae*). S. Kloofhout. 'n Boompie wat in oop woude van die Kaap tot in Natal en Transvaal voorkom.

KLIPHOUT. *Heeria argenteum* O. Ktze. (fam. *Anacardiaceae*). 'n Struik of boompie wat voorkom op klipperige grond in die Westelike Provincie. Die bas lewer looistof.

KLOOFHOUT. Sien KLIP-ELS.

KNOPPIESDORING. *Acacia pallens* Rolfe. (fam. *Leguminosae*). 'n Blaarwisselende boom van die Transvaalse Laeveld en Zoeloeland, wat met dik knopdorings beset is. Sien ook APIESDORING en PERDEPRAM.

KOBOBESSIE. *Cassine sphaerophylla* O. Kuntz.; S. *Elaeodendron sphaerophyllum* Presl. (fam. *Celastraceae*). S. Ghoeboebessie. 'n Boom van die Oostelike Provincie met eetbare vrugte. Sien ook SAFFRAAN.

KOFFIE-HARDEPEER. Sien KOFFIEPEER.

KOFFIEPEER. *Pleurostylia capensis* Oliv. (fam. *Celastraceae*). S. koffie-hardepeer; Hardepeer; Baster-saffraan. 'n Groot boom wat van die Oostelike Provincie tot in Natal voorkom.

KOOLHOUT. *Lachnostylis capensis* Turcz. (fam. *Euphorbiaceae*). 'n Struik of boompie van Knysna.

KREMETARTBOOM. *Adansonia digitata.* L. (fam. *Bombaceae*). S. Baobab. Die grootste boom in die wêreld wat dikte van stam betref. Kom van noordelike Transvaal tot in Middel-Afrika voor. Vrug bevat 'n droë pulp wat 'n suur smaak het. Gemeng met water gee dit 'n verfrissende drank soos kremetart.

KREUPELHOUT. *Leucospermum conocarpum* R.Br. (fam. *Proteaceae*). S. Luisies; Goudboom. 'n Struik of boompie van die Westelike Provincie met mooi geel blomhofies.

KRINKHOUT. *Securidaca longipedunculata* Frees. (fam. *Polygalaceae*). 'n Boom wat in die oostelike Transvaal en verder noord voorkom. Die hout is baie lig en sag. Die boom dra mooi pers blomme wat lekker ruik.

KRUISBESSIE. *Grewia occidentalis* L. (fam. *Tiliaceae*). 'n Struik of boompie in woude vanaf die Kaap tot in die Transvaal. Vrug in vier dele en lyk, van bo gesien, soos 'n kruisie.

KURK-EIK. *Quercus suber* L. (fam. *Fagaceae*). 'n Boom van Suid-Europa wat in die Kaapprovincie as sierboom aangekweek word. Die bas lewer kurk.

KWAR. *Canthium obovatum* Klotz.; S. *Plectronia obovata* Valeton (fam. *Rubiaceae*). 'n Timmerhoutboom wat van Knysna tot in Natal voorkom.

LAKBOOM. Sien KIAAT.

LAKHOUT. Sien KIAAT.

LEMOENDORING. *Gymnosporia buxifolia* Szysz. (fam. *Celastraceae*). S. Pendoring; Gifdoring. 'n Boompie wat in alle dele van die Unie voorkom. Die dorings lyk soos die van lemoenbome.

LEMOENHOUT. *Xymalos monospora* Baill.(fam.*Monimiaceae*). S. Borriehout. 'n Groot boom met geelgekleurde hout, wat voorkom in woude van die Oostelike Provincie tot in die Transvaal. Sien ook PERDEPIS.

LEPELHOUT. *Harlogia capensis* Thunb. (fam. *Celastraceae*). 'n Boompie van die Westelike Provincie. Die blare is soms hol soos lepels.

LOODHOUT. Sien HARDEKOOL.

LUISIES. Sien KREUPELHOUT.

MAHONIE. *Swietenia Mahogoni* Jacq. (fam. *Meliaceae*). 'n Boom van Middel-Amerika wat die bekende mahoniehout lewer. Sien ook RHODESIESE MAHONIE en NATALSE MAHONIE.

MALBAAR. *Brachylaena glabra* Druce; *S. B. dentata* (Thunb.) (fam. *Compositae*). 'n Boom van gemiddelde grootte wat van die Oostelike Provincie tot Natal voorkom.

MANITOKKA. *Myoporum insulare* R.Br.; S. *Myoporum serratum* R.Br. (fam. *Myoporaceae*). 'n Boompie uit Australië wat in die Westelike Provincie as sierboom en heiningplant aangekweek word.

MANNETJIE-DENNEBOOM. Sien SPAR-DEN.

MAROELA. *Sclerocarya caffra* Sond. (fam. *Anacardiaceae*). 'n Boom van die bosveldstreke van die Unie en verder noord, wat eetbare, gelerige vrugte dra. Die naam is Bantoe.

MATOEMIE. Sien MINGERHOUT.

MELKHOUT. Sien ROOIMELKHOUT en WITMELKHOUT.

MIMOSA. Sien DORINGBOOM.

MINGERHOUT. *Adina Galpini* Oliv. (fam. *Rubiaceae*). S. Watermatoemie; Matoemie. 'n Groot timmerhoutboom van Natal, Zoeloeland en die oostelike Transvaal.

MISPEL. *Vangueria infausta* Burch. (fam. *Rubiaceae*). S. Wildemispel. 'n Boompie wat van die Oostelike Provincie tot in die trope voorkom. Die eetbare vrugte laat aan die Europese mispels (*Mespilus germanica* L.) dink.

MOBOLA. Sien GRYSAPPELBOOM.

MOBOLA-PRUIM. Sien GRYSAPPELBOOM.

MOEPEL. *Mimusops Zeyheri* Sond. (fam. *Sapotaceae*). S. Rooimelkhout; Transvaalse Rooimelkhout. 'n Struik of boompie van die Transvaal met 'n eetbare vrug wat effens soos 'n mispel of moepel lyk. Die naam is Bantoe. Sien ook ROOIMELKHOUT.

MOPANIE. *Copaifera Mopane* Kirk. (fam. *Leguminosae*). 'n Tropiese boom wat ook in noordelike dele van die Unie aangetref word. 'n Bantoenaam.

MITSERIE. *Bridelia micrantha* Baill. (fam. *Euphorbiaceae*). 'n Boom van gemiddelde grootte, wat van Natal tot in die trope voorkom.

NABOOM. *Euphorbia tetragona* Haw. (fam. *Euphorbiaceae*). 'n Sukkulente boompie wat in die Oostelike Provincie en Natal voorkom. Ander *Euphorbia*-soorte —b.v. *E. grandidens* en in die Transvaal *E. Cooperi* en *E. ingens*—word ook soms NABOOM genoem. Die eerste gedeelte van die naam is Bantoe.

NATALSE KAFFERBOOM. *Erythrina Humei* E. Mey (fam. *Leguminosae*). 'n Struik of boompie wat van die Oostelike Provincie tot in die oostelike Transvaal voorkom.

NATALSE MAHONIE. Sien ESSENHOUT.

NATOU. *Ficus natalensis* Hochst. (fam. *Moraceae*). 'n Boom wat van die Kaap tot in Natal voorkom. Begin dikwels as epifiet, maar nadat dit die boom waaraan dit groei, dood gewurg het, groei dit as selfstandige boom verder.

NIESHOUT. *Ptaeroxylon obliquum*. Radlk. (fam. *Meliaceae*). 'n Boom wat van die Oostelike Provincie tot in Natal en Transvaal voorkom. Dit lewer die duursaamste hout wat ons het, en word veral vir heiningpale gebruik. As die saagsel opgesnuiwe word, veroorsaak dit hewige nies-buie.

NIKLAAS-KLAPPER. Sien ROOIBOS.

NOOIENSBOOM. Sien KIEPERSOL.

NOTSENG. Sien NOTSING.

NOTSING. *Halleria lucida*. L. (fam. *Scrophulariaceae*). S. Notseng; Kinderbessie; Ouhout; Wit-olienhout; Wit-olyf. 'n Boompie of struik wat van die Kaap tot in Oos-Afrika voorkom. Dit dra dikwels blomme en vrugte aan die stam. Die bessies word deur kinders geëet.

NOUPITJIE. Sien BERGPRUIM.

NOUPITTE. Sien BERGPRUIM.

NUWEHOUT. Sien BITTER-AMANDEL.

OEMSIMBEET. *Millettia caffra* Meisn. (fam. *Leguminosae*). S. Kaffer-ysterhout. 'n Groot boom, wat oos van die Kei tot in Natal voorkom. Kaffers sny graag kieries, wat lig gekleurde spint sowel as donker kernhout bevat, uit die hout van hierdie boom. Xosa *Umzimbiti*.

OKKERNEUT. *Juglans regia* L. (fam. *Juglandaceae*). 'n Groot boom van Oos-Europa en Asië, wat die bekende neute en waardevolle meubelhout lewer.

OLIENHOUT. *Olea verrucosa* Link. (fam. *Oleaceae*). S. Wilde-olyfboom; Oliewenhout; Olywenhout; Olynhout. 'n Boom wat baie na verwant is aan die Europese Olyfboom, maar die vrugte is kleiner. Dit word in alle dele van die Unie gevind waar die reënval nie te laag is nie. Sien ook BASTER-OLIENHOUT en NOTSING.

OLIEPITTE. Sien BERGPRUIM.

OLIEWENHOUT. Sien OLIENHOUT.

OLIFANTSHOUT. Sien VANWYKSHOUT.

OLIFANTSOOR. *Lonchocarpus Capassa* Rolfe. (fam. *Leguminosae*). 'n Boom met baie groot blare wat in Zoeloeland en die oostelike Transvaal voorkom.

OLM. Sien IEP.

OLYNHOUT. Sien OLIENHOUT.

OLYWENHOUT. Sien OLIENHOUT.

ONBEKENDE BOOM. Sien KAMEDEBO-STINKHOUT.

ONDERBOS. *Trichocladus crinitus* Pers.; *T. ellipticus* E. et Z.; *T. grandiflorus* Oliv. (fam. *Hamamelidaceae*). Struike of boompies in woude. *T. grandiflorus* kom in Transvaal voor. Die ander twee soorte kom van Knysna tot in Natal voor. Die boompies groei onder ander bome.

OPGEITJIES. *Gardenia neuberia* E. et Z. (fam. *Rubiaceae*). 'n Boompie met eetbare vrugte wat van die Oostelike Provincie tot in Natal en Transvaal voorkom.

OPREGTE GEELHOUT. Sien REGTE GEELHOUT.

OUBOS. Sien OUHOUT.

OUDORING. *Acacia robusta* Burch. (fam. *Leguminosae*). S. Engeldoring; Engelse Doring; 'n Boom van karoïede veld en die Bosveld. Sien ook AAPKOP.

OUHOUT. (1) *Cordia caffra* Sond. (fam. *Boraginaceae*). S. Septee. 'n Boom van gemiddelde grootte wat veral langs die kus van Uitenhage tot in Natal voorkom.

(2) *Leucosidea sericea* E. et Z. (fam. *Rosaceae*). S. Oubos. 'n Struik of boompie wat van die Oostelike Provincie tot in Transvaal voorkom. Die stamhout brand of smoor stadig soos ou, vrot hout. Sien ook NOTSING.

OUTENIEKWA-GEELHOUT. *Podocarpus falcatus* R.Br. ex Mirb. (fam. *Podocarpaceae*). S. Kalander; Kalander-geelhout; Bastergeelhout. Die hoogste, Suid-Afrikaanse boomsoort. Dit kom voor van die Grootvadersbos by Swellendam tot in Natal. Dit lewer waardevolle timmerhout. Sien ook GEELHOUT.

PATULA-DEN. *Pinus patula* Schl. et Cham. (fam. *Pinaceae*). 'n Vinniggroeiende denneboom van Mexiko, wat in die hoë somerreënvaldele van die Unie aangekweek word.

PEER. Verskeie bome dra die naam peer b.v. WITPEER; HARDEPEER en DORINGPEER, omdat die hout of die blare soos die van die bekende vrugteboom lyk.

PENDORING. Sien DORINGBOOM en LEMOENDORING.

PEPERBOOM. *Schinus molle* L. (fam. *Anacaediaceae*). 'n Sierboom uit Middel- en Suid-Amerika wat veral in die droë dele van die Unie aangekweek word. Die rooi bessies het 'n skerp pepersmaak.

PERDEPIS. *Clausena inaequalis* Bth. (fam. *Rutaceae*). S. Lemoenhout. 'n Struik of boompie wat van Knysna tot Noord-Afrika voorkom. Wanneer die blare gekneus word, ruik hulle sterk na die urine van 'n perd. Sien ook BASTERPERDEPIS.

PERDEPRAM. *Fagara capensis* Thunb.; *F. Davyi* Verdoorn (fam. *Rutaceae*). S. Wildekarmonk; Knoppiesdoring. Bome met eienaardige knoppe aan die stamme—vanwaar die populaire naam. Die bome kom in woude van die Kaap tot in Transvaal voor. Die sade ruik sterk.

PLATAAN. Alle soorte van die geslag *Platanus* (fam. *Platanaceae*). Sierbome van die noordelike halfrond, wat veral as straatbome in die Unie aangekweek word.

PLATKROON. *Albizzia gummifera* C. A. Smith (fam. *Leguminosae*). 'n Boom van gemiddelde grootte met 'n kroon wat bo plat is. Dit kom voor van Port St. Johns noordooswaarts tot in Middel-Afrika.

POPULIER. Alle soorte van die geslag *Populus* (fam. *Salicaceae*). Bome van Europa en Noord-Amerika, wat op klam grond in die Unie aangekweek word. Sien ook ITALIAANSE POPULIER en VAAL-POPULIER.

PRUIM. Die naam word aan verskeie bome, met vrugte wat soos 'n pruim lyk, gegee, b.v. KAFFERPRUIM en PRUIMBAS.

PRUIMBAS. Sien BERGBAS.

PRUIMBESSIE. Sien BERGPRUIM.

RAASBOS. Sien ROOIBOS.

REGOP-GEELHOUT. Sien REGTE GEELHOUT.

REGTE GEELHOUT. *Podocarpus latifolius* R.Br. (fam. *Podocarpaceae*). S. Opregte Geelhout; Regop-geelhout. 'n Baie groot boom wat in woude van die Kaap tot in Transvaal voorkom. Dit lewer waardevolle timmerhout. Die oorspronklike naam was REGOP-GEELHOUT, maar dié is later vervang deur REGTE- of OPREGTE GEELHOUT, waarskynlik om aan te dui dat nie die BASTER-GEELHOUT bedoel is nie. Sien ook GEELHOUT.

RESPIES. Sien HARPUIS.

REUSEBOOM. *Sequoia gigantea* Decsne (fam. *Taxodiaceae*). Die grootste boom van die wêreld, maar nie die hoogste nie. In die natuurlike groeiplek in Kalifornië, Verenigde State van Amerika, bereik dit 'n hoogte van 300 voet en 'n omvang van 100 voet. Die bome word soms in die Unie aangeplant.

RHODESIESE MAHONIEBOOM. *Afzelia quanzensis* Welw. (fam. *Leguminosae*). S. Chemnen. 'n Boom wat in die Bosveld gevind word, maar veral in Rhodesië tuis hoort. Die harde, swart sade met oranje tot skarlakenrooi saadmantels word dikwels as rariteite bewaar.

RIVIER-VADERLANDSWILG. *Combretum glomeruliflorum* var. *riparium* Burtt Davy (fam. *Combretaceae*). 'n Boom langs riviere in Natal en in die Bosveld en Hoëveld van die Transvaal. Sien ook VADERLANDSWILG. en ROOIBLAD.

RIVIERWILG. Sien WILDE WILGERBOOM.

ROOIBAS. Sien AAPKOP.

ROOIBESSIE. (1) *Olinia cymosa* Thunb. (fam. *Oliniaceae*). S. Hardepeer; Berghardepeer; Rooihout. 'n Boom van gemiddelde grootte, wat van die Kaap tot in Abssynië voorkom. Dit dra rooi vrugte van omtrent 'n kwartduim in deursnit. (2) *Olinia emarginata* Burtt Davy (fam. *Oliniaceae*). S. Transvaalse Hardepeer. 'n Boom van gemiddelde grootte wat op berge in die oostelike Transvaal voorkom. Die vrugte is ook rooi.

ROOIBLAAR. Sien ROOIBLAD.

ROOIBLAD. (1) *Combretum Kraussii* Hochst. (fam. *Combretaceae*). S. Bosvaderlandswilg; Rooiblaar. 'n Groot boom wat in woude van die Transkei tot in die Transvaal voorkom. Die blare word rooi in die winter.

(2) *Combretum glomeruliflorum* var. *obscurum* Burtt Davy (fam. *Combretaceae*). S. Rooiblaar. 'n Taamlike groot boom langs die Oranje-, Vaal- en ander riviere. Blare word rooi in die winter.

ROOIBOEKENHOUT. *Faurea Galpini* Phillips (fam. *Proteaceae*). 'n Struik of boompie van die oostelike Transvaal. *Faurea*-soorte word in Natal en Transvaal Boekenhout genoem, omdat die hout tot 'n sekere mate soos die van die beter bekende BOEKENHOUT van die Kaapprovincie lyk. Sien ook BOSBOEKENHOUT; SWARTBOEKENHOUT en BREËBLAARBOEKENHOUT.

ROOIBOS. (1) *Combretum Zeyheri* Sond. (fam. *Combretaceae*). S. Raasbos; Nicklaasklapper; Warmkos. 'n Boom van Natal en die oostelike Transvaal.

(2) *Combretum apiculatum* Sond. (fam. *Combretaceae*). 'n Boompie van Natal en die oostelike Transvaal. Sien ook ROOIBLAD.

ROOIDORING. Sien AAPKOP.

ROOI-ELS. *Cunonia capensis* Linn. (fam. *Cunoniaceae*). 'n Meubelhoutboom met mooi, rooi hout wat langs waterstrome van die Kaap tot in Natal voorkom. Sien ook ELS en WIT-ELS.

ROOI-ESSENHOUT. Sien ESSENHOUT.

ROOIHAAK. Sien AAPKOP.

ROOIHAAKDORING. Sien AAPKOP.

ROOIHOUT. *Ochna arborea* Burch. (fam. *Ochnaceae*). 'n Boompie wat van Kuysna tot in die Transvaal voorkom. Die kleur van die hout is ligrooi. Sien ook ROOI-YSTERHOUT; ROOI-BESSIE en ROOILEMOEN.

ROOI-IVOOR. Sien ROOILEMOEN.

ROOIKAREE. Sien KAREEBOOM.

ROOIKRANS. *Acacia cyclopis*. A. Cunn. (fam. *Leguminosae*). S. Stinkboontjies. 'n Australiese boompie wat in die Unie dikwels vir die vaslegging van sandduine en vir vuurmaakhout aangekweek word. 'n Rooi saadmantel is soos 'n kransie om die swart sade geleë. Die sade gee 'n slegte ruik af as hulle gekneus en nat gemaak word.

ROOILEMOEN. *Rhamnus Zeyheri* Sond. (fam. *Celastraceae*). S. Rooi-ivoor; Rooihout. 'n Boompie van Natal en die oostelike Transvaal. Die hout is dig en swaar en het 'n rooi kleur.

ROOIMELKHOUT. *Mimusops obovata* Sond. (fam. *Sapotaceae*). S. Moepel. 'n Groot boom wat van die Oostelike Provincie tot in die Transvaal voorkom. Die vrug, wat effens soos 'n mispel lyk, is eetbaar. Sien ook MOEPEL.

ROOIPEER. (1) *Scolopia Mundtii* Warb. (fam. *Flacourtiaceae*). S. Bergsaffraan; Klipdoring. 'n Timmerhoutboom wat van die Kaap tot in Natal en Transvaal voorkom. Hout word veral deur wamakers gebruik.

(2) *Scolopia Ecklonii* Szysz. (fam. *Flacourtiaceae*) S. Bergsaffraan. 'n Boom wat van die Oostelike Provincie tot in Transvaal voorkom.

ROOISPEKBOOM. Sien VADERLANDSROOIHOUT.

ROOISPEKHOUT. Sien VADERLANDSROOIHOUT.

ROOISTINKHOUT. Sien BITTER-AMANDEL.

ROOI-WAG-'N-BIETJIE. *Acacia Gillilliae* Burtt Davy. (fam. *Leguminosae*). S. Swarthaakdoring. 'n Boom van gemiddelde grootte wat in Zoeloeland en die oostelike Transvaal voorkom. Die kernhout is rooi gekleur.

ROOI-YSTERHOUT. *Ochna Holstii* Engl. (fam. *Ochnaceae*). S. Rooihout. 'n Boom van woude in die oostelike en noordelike Transvaal. Binnekant van bas is rooi gekleur. *O. O'Connori* Phillips, van dieselfde dele, word ook soms ROOI-YSTERHOUT genoem.

RUIKPEUL. *Acacia Benthami* Rochbr. (fam. *Leguminosae*). S. Lekkerruikpeul; Stinkpeul. 'n Boompie met 'n plat kroon van die Bosveld en verder noord. Die ryp peule het 'n soeterige ruik.

SAFFRAAN. *Cassine croceum* Kuntze (fam. *Celastraceae*). 'n Groot timmerhoutboom wat van die Kaap tot in Natal voorkom. Die bas het 'n geel kleur wat aanleiding gegee het tot die naam. Ander *Cassine*-soorte word ook soms SAFFRAAN genoem. Sien ook KOBOBESSIE; KOFFIEPEER en ROOIPEER.

SALIE. *Chilianthus arboreus*. A.DC. (fam. *Loganiaceae*). S. Wildevlier; Basterolienhout. 'n Struik wat naby woude vanaf Caledon noordooswaarts voorkom. Sien ook BITTERBLAAR; KANFERHOUT; SALIEHOUT en WIT-SALIE.

SALIEHOUT. *Buddleia salviaefolia* Lam. (fam. *Loganiaceae*). S. Wit-salie. 'n Struik of boompie wat van die Cederberge en Swartberge na die ooste en noorde voorkom. Blare lyk soos die van SALIE. Sien ook SALIE; BITTERBLAAR en KANFERHOUT.

SALIGNA-GOMBOOM. *Eucalyptus saligna* Smith. (fam. *Myrtaceae*). 'n Groot Australiese gomboom wat baie in die Unie aangekweek word.

SAMBREELBOOM. Sien KIEPERSOL.

SANDVAALBOS. Sien VAALBOS.

SAPREE. *Widdringtonia cupressoides* Endl. (fam. *Cupressaceae*). S. Bergsapree; Bergcypres; Bobbejaankers; Dupresknop. 'n Digte struik of boompie wat van die Kaap noordooswaarts voorkom. Die naam SAPREE is waarskynlik afkomstig van Frans *cyprès* en dit is moontlik 'n Hugenote-woord. Die boompie lyk baie soos 'n egte cypres. Sien ook TRANSVAALSE BERGCYPRES.

SEERBOS. *Ochna pulchra* Hook (fam. *Ochnaceae*). S. Seermaak. 'n Blaarwisselende boompie van die oostelike Transvaal.

SEERMAAK. Sien SEERBOS.

SEKELBOS. *Dichrostachys glomerata* Hutch. et Daly (fam. *Leguminosae*). 'n Boompie met sekelvormige peule wat in Natal en die oostelike Transvaal voorkom.

SEPTEE. Sien OUHOUT.

SERING. (1) *Burkea africana* Hook (fam. *Leguminosae*). S. Wildesering. 'n Boompie van die Transvaalse Bosveld en verder noord. Die aangenaam-ruikende blomtrosse laat aan die TUINSERING dink.

(2) *Syringa vulgaris* L. (fam. *Oleaceae*). S. Tuinsering. Europese struik of boompie wat in tuine aangekweek word. Dit dra groot trosse wit of pers blomme wat lekker ruik.

(3) *Melia azedarach* L. (fam. *Meliaceae*). 'n Boom van gemiddelde grootte uit Indië wat groot trosse pers blomme dra. Dit word dikwels as sierboom in die Unie aangekweek. Sien ook WITSERING.

SIERIEHOUT. Sien KANFERHOUT.

SILWERBOOM. *Leucadendron argenteum* (L) R.Br. (fam. *Proteaceae*). S. Witboom. 'n Boom wat alleenlik op die Kaapse skiereiland voorkom. Waar dit elders in die Unie gevind word, is dit aangeplant. Die blare is met 'n digte laag silwer blare bedek.

SKAAPDROLLETJIE. Sien BOKDROL.

SLAPLOOT. *Kirkia Wilmsii* Engl. fam. *simarubaceae*). 'n Blaarwisselende boompie van die Transvaalse Bosveld.

SMALBLAAR. *Maba natalensis* Harv. (fam. *Ebenaceae*). 'n Boom wat van Oos-Londen ooswaarts deur Natal langs die kus voorkom.

SOETDORING. Sien DORINGBOOM.

SOETKAREE. Sien KAREEBOOM.

SPAR-DEN. *Pinus pinaster* Ait.; S. *Pinus maritima* Lam. (fam. *Pinaceae*). S. Mannetjie-denneboom. 'n Suid-Europese denneboom wat in die Unie aangekweek word.

SPEEKHOUT. Sien VLIER.

SPEKBOOM. *Portulacaria afra* Jacq. (fam. *Portulacaceae*). 'n Sukkulente boompie wat in karoïede veld in die Oostelike Provincie voorkom.

SPEKEHOUT. Sien VANWYKSHOUT.

SPEKHOUT. Sien VADERLANDSROOIHOUT.

SPELONKE-TEE. Sien BOESMANSTEE.

STAMPERHOUT. Sien DEURMEKAAR.

STAMVRUGTE. *Chrysophyllum magalismontanum* Sond. (fam. *Sapotaceae*). 'n Struik of boom wat in die oostelike en noordelike Transvaal voorkom. Die vrugte wat aan die stam voorkom, is eetbaar.

STEELBOOM. Sien KIERIEKLAPPER.

STERKBAS. *Peddica africana* Harv. (fam. *Thymelaeaceae*). 'n Struik of boompie wat van die Oostelike Provincie tot in Transvaal voorkom. Dit lewer sterk basvesels.

STINKBOONTJIES. Sien ROOIKRANS.

STINKHOUT. *Ocotea bullata* E. Mey. (fam. *Lauraceae*). S. Swartstinkhout. 'n Groot boom wat van die Kaap tot in Transvaal voorkom. Dit lewer die waardevolste Suid-Afrikaanse meubelhout. Die hout gee 'n onaangename ruik af wanneer dit geskawe word.

STOMPDORING. Sien WILDEKATJIEPIERING.

SUPREE. Sien KANFERHOUT.

SUURBESSIES. *Dovyalis rhamnoides* Harv.; *D. rotundifolia* Harv. (fam. *Flacourtiaceae*). S. Wynbessies. Struike of boompies wat van die Oostelike Provincie tot in Transvaal voorkom. Vrugte het 'n aangename suur smaak, en word ook gebruik om konfyt van te kook.

SUURKLAPPER. *Strychnos Schumanniana* Gilg. (fam. *Loganiaceae*). 'n Boompie met eetbare vrugte van Zoeloeland en die oostelike Transvaal. Die groot ronde vrugte, wat aan 'n klapper laat dink, bevat 'n suur pulp.

SUURPRUIM. (1) *Ximenia americana* L.; (2) *X. caffra* Sond. (fam. *Olaceae*). S. Wildepruim. Struike of boompies van Natal en die oostelike Transvaal. Die vrug lyk soos 'n pruimpie. Sien ook KAFFERPRUIM.

SWARTBAS. *Royena lucida* Linn. (fam. *Ebenaceae*). S. Tolletjie. 'n Boompie wat van die Kaap tot in Transvaal voorkom. Bas is swart gekleur.

SWARTBOEKENHOUT. *Faurea saligna* Harv. (fam. *Proteaceae*). S. Bosveldboekenhout; Rooiboekenhout; Transvaalse Boekenhout. 'n Struik of boom wat voorkom van die Egossa in Natal tot in die Transvaal. Sien ook BOEKENHOUT, ROOIBOEKENHOUT en BREËBLAAR-BOEKENHOUT.

SWARTBOS. Sien BLOUBOS.

SWART-EBBENHOUT. Sien EBBENHOUTBOOM.

SWARTHAAK. Sien AAPKOP en HAAKDORING.

SWARTHAAKDORING. Sien AAPKOP en ROOI-WAG-'N-BIETJIE.

SWARTHOUT. *Gymnosporia peduncularis* L. Bolus. (fam. *Celastraceae*). 'n Boom wat van die Kaap noordooswaarts tot in Transvaal voorkom. Kernhout is byna swart.

SWARTSTINKHOUT. Sien STINKHOUT.

SWART-YSTERHOUT. *Olea laurifolia* Lam. *Oleaceae*). S. Ysterhout. 'n Groot boom wat van die Kaap tot in Noord-Afrika voorkom. Hout is baie hard en kernhout is dikwels swart gekleur. Sien ook YSTERHOUT.

SYBAS. *Gymnosporia acuminata* Szysz. (fam. *Celastraceae*). 'n Boompie wat van die Kaap tot in Transvaal voorkom. Blare en bas bevat wit sydraadjies.

TAAIBOS. *Rhus obovata* Sond; *R. pyroides* Burch. (fam. *Anacardiaceae*). Struike of boompies met taai bas sodat die takkies nie maklik kan afgebreek word nie. Ander *Rhus*-soorte word ook soms Taaibos genoem. Sien ook BASTERKAREE en BOSTAAIBOS.

TAMBOTIE. *Spirostachys africana* Sond. (fam. *Euphorbiaceae*). 'n Groot blaarwisselende boom van die Bosveld en verder suid tot in die Transkei.

TEERHOUT. *Loxostylis alata* Spreng. (fam. *Anacardiaceae*). S. Tierhout. 'n Boompie van die Oostelike Provincie en Natal wat 'n bietjie soos 'n PEPERBOOM lyk.

TERBLANS. *Faurea Macnaughtonii* Phill. (fam. *Proteaceae*). 'n Boom wat by Knysna en ook in Natal, Transvaal en in die Transkei voorkom. Dit lewer 'n pragtige liggekleurde meubelhout.

TIERHOUT. Sien TEERHOUT.

TOLBALLIE. *Tricalysia lanceolata* K. Schum. (fam. *Rubiaceae*). 'n Boompie wat langs die kus van die Oostelike Provincie tot in Transvaal voorkom.

TOLLETJIE. Sien SWARTBAS.

TRANSVAALSE BERGCYPRES. *Widdringtonia Whytei* Rendle. (fam. *Cupressaceae*). 'n Boompie wat in die oostelike Transvaal en verder noord voorkom. Sien ook SAPREE.

TRANSVAALSE BOEKENHOUT. Sien SWARTBOEKENHOUT.

TRANSVAALSE BOERBOON. *Schotia transvaalensis* Rolfe. (fam. *Leguminosae*). 'n Boom uit die Transvaalse Bosveld. Sien ook BOERBOON.

TRANSVAALSE HARDEPEER. Sien ROOIBESSIE.

TRANSVAALSE KEUR. (1) *Calpurnia sylvatica* E. Mey. (fam. *Leguminosae*). 'n Boompie met geel blomme wat van die Oostelike Provincie tot Natal en Transvaal voorkom.

(2) *Calpurnia lasiogyne* E. Mey. (fam. *Leguminosae*). 'n Bosboompie wat van Natal tot Transvaal en verder noord voorkom. Blomme is geel.

TRANSVAALSE KIAAT. Sien KIAAT.

TRANSVAALSE ROOIMELKHOUT. Sien MOEPEL.

TRANSVAALSE SAFFRAAN. *Gymnosporia deflexa* Sprague. (fam. *Celastraceae*). 'n Groot boom van die oostelike Transvaal. Dit word SAFFRAAN genoem omdat die bas binne geel is. Sien ook SAFFRAAN.

TREURWILGER. *Salix babylonica* L. (fam. *Salicaceae*). S. Wilgerboom; Wilgeboom. 'n Chinese boom met hangende takke wat in Suid-Afrika langs water groei. Sien ook WILDEWILGERBOOM.

TUINSERING. Sien SERING.

VAALBOOM. Sien VAALBOS.

VAALBOS. (1) *Brachylaena discolor* D.C. (fam. *Compositae*). S. Bosvaalbos. 'n Boompie van die kusstreke van die Oostelike Provincie en Natal.

(2) *Terminalia sericea* Burch. (fam. *Combretaceae*). S. Geelhout; Vaalboom; Bloubos; Sandvaalbos. 'n Groot boom van die Bosveld. Die blare blink soos dié van die Silwerboom. Sien ook KANFERHOUT.

VAALDORING. Sien VAALKAMEELDORING.

VAALKAMEELDORING. *Acacia haematoxylon* Willd. (fam. *Leguminosae*). S. Vaaldoring. 'n Betsjoeanalandse boompie

VAALPOPULIER. *Populus canescens* Smith (fam. *Salicaceae*). 'n Europese boom wat in die Unie op klam grond aangekweek word veral vir vuurhoutjiehout.

VADERLANDSROOIHOUT. *Kiggelaria africana* L. (fam. *Flacourtiaceae*). S. Wilderperske; Spekhout; Rooispekhout; Rooispekboom. 'n Boompie wat van die Kaap tot in die Transvaal voorkom. Die blare lyk soms soos die van 'n perskeboom maar variëer baie. Die hout is ligrooi van kleur.

VADERLANDSWILG. Sien WATERPEER.

VANWYKSHOUT. *Bolusanthus speciosus* Harms. (fam. *Leguminosae*). S. Olifantshout; Spekehout. 'n Boom met mooi blou blomme wat in die Transvaal, Zoeloeland en verder noord voorkom.

VLIER. *Lachnopylis floribunda* C. A. Smith. (fam. *Loganiaceae*). 'n Boom wat van die Kaap tot in Transvaal voorkom. Dit dra groot trosse wit blomme wat aan die van die Europese VLIER (*Sambucus nigra* L.) laat dink. Sien ook SALIE.

WAAIBOOM. Sien KIEPERSOL.

WABOOM. *Protea grandiflora* Linn. (fam. *Proteaceae*). 'n Boompie wat teen berghange in die Westelike Provincie voorkom. Hout is vroeër gebruik vir vellings van waens.

WAG-'N-BIETJIE. Die naam WAG-'N-BIETJIE word aan baie struike en bome met haakdorings gegee. Sien ook BLINKBLAAR-WAG-'N-BIETJIE; DROOG-MY-KEEL; HAAKDORING; KATDORING en ROOI-WAG-'N-BIETJIE.

WARMIKOS. Sien ROOIBOS.

WATERBESSIE. *Syzygium cordatum* Hochst. (fam. *Myrtaceae*). S. Waterboom; Waterhout. 'n Boom van gemiddelde grootte wat van die Visrivier tot by die Zambesi voorkom. Dit groei veral langs lopende water en dra eetbare bessies.

WATERBOOM. Sien WATERBESSIE en WITHOUT.

WATERHOUT. Sien WATERBESSIE en WITHOUT.

WATER-MATOEMIE. Sien MINGERHOUT.

WATERPEER. *Syzygium Gerrardii* Hochst. (fam. *Myrtaceae*). S. Vaderlandswilg. 'n Groot boom wat in woude in die oostelike Transvaal en verder suid tot by die Egossawoud voorkom.

WATER-WIT-ELS. *Brachylaena neriifolia*. R.Br. (fam. *Compositae*). 'n Struik of boompie langs riviere in die suidwestelike Kaapprovincie.

WATTEL. Verafrikaanste vorm van die Engelse woord Wattle, wat in die Unie gebruik word veral vir *Acacia*-soorte wat looibas lewer. Sien ook BASBOOM.

WESTELIKE ESSENHOUT. Sien BOSTAAIBOS.

WILDE-AMANDEL. *Brabeium stellatifolium* L. (fam. *Proteaceae*). S. Ghoeboontjie; Hottentotsamandel. Boompie of struik wat langs riviere in die Westelike Provincie groei. Die vrug lyk soos 'n amandel, maar is giftig. Vroeër het die Hottentotte en kleurlinge dikwels die vrugte of „boontjies" uitgevars en ghoekoffie daarvan gemaak. Ghoe is Hottentots. Sien ook BERGPRUIM.

WILDE-APPEL. *Trimeria grandiflora* Warb. (fam. *Flacourtiaceae*). S. Wilde-appelkoos; Wildemoerbei; Grootblaar-ysterhout. 'n Boompie of struik wat van Knysna tot in die Transvaal voorkom.

WILDE-APPELKOOS. *Dovyalis tristis* Sond. (fam. *Flacourtiaceae*). 'n Struik of boompie wat van die Oostelike Provincie tot in Transvaal voorkom. Vrugte is eetbaar. Sien ook WILDE-APPEL.

WILDEGRANAAT. Sien BUFFELSHORING.

WILDEJAMBOES. *Eugenia Zeyheri* Harv. (fam. *Myrtaceae*). 'n Boompie wat van die Oostelike Provincie tot in Natal voorkom. Die vrug is eetbaar.

WILDEKARMONK. Sien PERDEPRAM.

WILDEKASTAIING. *Calodendron capense* Thunb. (fam. *Rubiaceae*). 'n Groot timmerhoutboom wat van Swellendam noordooswaarts tot in die Transvaal voorkom. Dit dra baie mooi blomme. Die vrug lyk 'n bietjie soos die egte Kastaiing. Sien ook KASTAIING.

WILDEKATJIEPIERING. *Gardenia Thunbergia* L. (fam. *Rubiaceae*). S. Buffelsbal; Stompdoring. 'n Struik of boompie wat vanaf die Oostelike Provincie noordooswaarts tot in Middel-Afrika groei. Die groot ronde vrug het waarskyn-

lik aanleiding gegee tot die naam Buffelsbal. Die naam KATJIEPIERING is van Maleise oorsprong en is saam met die bekende tuinstruik ingevoer uit die Ooste. Sien ook AAPSEKOS.

WILDEKWEPER. (1) *Cryptocarya Liebertiana* Engl. (fam. *Lauraceae*). 'n Hoë boom van die oostelike Transvaal.
(2) *Androstachys Johnsoni* Prain. (fam. *Euphorbiaceae*). 'n Boom van die Lebombo- en Soutpansberge en Zoeloeland.

WILDELAVENTEL. *Heteropyxis natalensis* Harv. (fam. *Myrtaceae*). 'n Boompie of struik wat lekker ruik en in Natal en Transvaal voorkom.

WILDEMISPEL. Sien MISPEL.

WILDEMOERBEI. Sien WILDE-APPEL.

WILDE-OLYFBOOM. Sien OLIENHOUT.

WILDEPERSKE. Sien VADERLANDSROOIHOUT.

WILDEPRUIM. Sien BERGPRUIM en SUURPRUIM.

WILDESERING. Sien SERING.

WILDEVLIER. Sien SALIE.

WILDEVYEBOOM. *Ficus capensis*. Thunb. (fam.*Moraceae*). S. Bosvy. 'n Groot boom wat van Knysna noordooswaarts tot in die Transvaal voorkom. Die vrugte (vye) is 'n duim of meer in deursnit.

WILDEWILGERBOOM. *Salix capensis* Thunb. (fam. *Salicaceae*). S. Rivierwilg. 'n Boom wat langs riviere voorkom in baie dele van die Unie, maar veral langs die Vaal- en Oranje-riviere en hulle systrome. Sien ook TREURWILGER.

WILGEBOOM. Sien TREURWILGER.

WILGERBOOM. Sien TREURWILGER en WILDEWILGERBOOM.

WITBOEKENHOUT. Sien BOEKENHOUT.

WITBOOM. *Maerua caffra* Sim. (fam. *Capparidaceae*). S. Witbos; Witboshout; Withoutboom. 'n Boompie met witgekleurde hout wat van Knysna tot in Natal en Transvaal voorkom. Sien ook SILWERBOOM en WITGAT.

WITDORING. Sien DORINGBOOM.

WIT-ELS. *Platylophus trifoliatus* Don. (fam. *Cunoniaceae*). 'n Boom van gemiddelde grootte wat langs waterstrome van die Kaap tot by die Visrivier voorkom.

WITGAT. *Boscia albitrunca* Gilg. et Ben. (fam. *Capparidaceae*). S. Witgatboom; Grootwitgatboom; Witstam; Witboom. 'n Boompie wat wyd versprei is in die droër dele van die Unie.

WITGATBOOM. Sien WITGAT en KAMDEBO-STINKHOUT.

WITHAAK. Sien HAAK-EN-STEEK.

WITHOUT. *Ilex mitis* Radlk. (fam. *Aquifoliaceae*). S. Waterhout; Witwaterhout. 'n Boom van gemiddelde grootte wat langs waterstrome van die Kaap tot in die Transvaal voorkom. Die hout is wit gekleur.

WITMELKHOUT. *Sideroxylon inerme* Linn. (fam. *Sapotaceae*). S. Melkhout; Jakhalsbessie. 'n Boom wat van die Kaap tot in Natal, veral langs die seekus, voorkom.

WIT-OLIENHOUT. Sien NOTSING.

WIT-OLYF. Sien NOTSING.

WITPEER. *Apodytes dimidiata* E. Mey. (fam. *Icacinaceae*). 'n Waardevolle timmerhoutboom van gemiddelde grootte wat in woude van die Kaap tot in die Transvaal voorkom.

WIT-SALIE. *Lachnopylis congesta* C. A. Smith (fam. *Loganiaceae*). 'n Boom wat van die Kaap tot in Natal, Transvaal en verder noord voorkom. Sien ook SALIEHOUT en SALIE.

WIT-SERING. *Kirkia acuminata* Oliv. (fam.*Simarubaceae*). 'n Boom van gemiddelde grootte wat in die Transvaalse Bosveld en verder noord voorkom.

WITSTAM. Sien WITGAT.

WITSTINKHOUT. Sien KAMDEBO-STINKHOUT.

WITWATERHOUT. Sien WITHOUT.

WIT-YSTERHOUT. *Vepris lanceolata* G. Don. (fam. *Rutaceae*). 'n Groot timmerhoutboom wat in woude van die Kaap tot in die trope voorkom.

WOLWEBOONTJIE. Sien GIFBOOM.

WOLWEDORING. Sien DORINGPEER.

WOLWEGIF. Sien GIFBOOM.

WONDERBOOM. *Ficus Pretoriae* Burtt Davy. (fam. *Moraceae*). 'n Groot boom wat van Natal tot in die trope voorkom. Die beroemde Wonderboom naby Pretoria is van hierdie soort.

WYNBESSIES. Sien SUURBESSIES.

WYNRUIT. Sien HAAKDORING.

YSTERHOUT. *Olea capensis* L. (fam. *Oleaceae*). S. Swart-ysterhout. 'n Boompie met groot, wit blomtrosse wat in woude van die Kaapprovincie en Natalse kus ——voorkom. Sien ook BASTER-YSTERHOUT; WIT-YSTERHOUT; SWART-YSTERHOUT; GROOTBLAAR-YSTERHOUT; OEMSIMBEET en ROOI-YSTERHOUT.

LATYNSE BOOMNAME EN AFRIKAANSE EKWIVALENTE

Acacia-soorte (Inheems.) Doringbome.
albida Del. : Anaboom; Apiesdoring.
Benthami Rochbr. : Ruikpeul; Lekkerruikpeul : Stinkpeul.
Burkei Bth. : Apiesdoring; Haakdoring; Knoppiesdoring.
caffra Willd. : Katdoring; Kaffer-wag-'n-bietjie.
cyclopis A. Cunn. : Rooikrans; Stinkboontjies.
decurrens Willd. : Basboom; Wattel.
delagoensis Harms. : Apiesdoring.
detinens Burch. : Haakdoring; Swarthaak; Hakiesdoring; Wynruit; Wag-'n-bietjie; Blouhaak.
Galpini Burtt Davy : Apiesdoring.
Gerrardii Bth. : Aapkop; Engelse Doring; Rooibos; Swarthaak; Rooihaak; Rooidoring; Oudoring; Swarthaakdoring; Rooihaakdoring.
Gillittiae Burtt Davy : Rooi-wag-'n-bietjie; Swarthaakdoring.
giraffae Burch. : Kameeldoring.
haematoxylon Willd. : Vaalkameeldoring; Vaaldoring.
litakunensis Burch. : Haak-en-steek; Baster-kameeldoring; Withaak.
Mollissima Willd. : Basboom; Wattel.
pallens Rolfe : Knoppiesdoring.
Rehmanniana Schinz : Engelsmansdoring.
robusta Burch. : Oudoring; Engeldoring; Engelse Doring; Brosdoring.
Acokanthera venenata G. Don : Gifboom.
Adansonia digitata L. : Kremetartboom; Baobab.
Adina Galpini Oliv. : Mingerhout; Watermatoemie; Matoemie.
Afzelia quanzensis Welw. : Rhodesiese Mahonieboom, Chemnen.
Albizzia gummifera C. A. Smith : Platkroon.
Alnus-soorte. Els.
Androstachys Johnsoni Prain : Wildekweper.
Apodytes dimidiata E. Mey. : Witpeer.
Bersama Stayneri Phill. : } Bitterbas.
Swinnyi Phill. : } Bitterbas.
Tysoniana Oliv. : } Bitterbas.
Bolusanthus speciosus Harms. Vanwykshout; Olifantshout; Spekehout.
Boscia albitrunca Gilg. et Ben. : Witgat; Witgatboom; Groot-witgatboom; Witstam; Witboom.
Brabeium stellatifolium L. : Wilde-amandel; Ghoeboontjie; Hottentots-amandel.
Brachylaena dentata (Thunb.) Less. : Sien *B. glabra*, Druce.
discolor D.C. : Vaalbos; Bosvaalbos.
elliptica Less. : Bitterblaar; Salie.
glabra Druce : Malbaar.
neriifolia R.Br. : Water-wit-els.
Bridelia micrantha Baill. Mtserie.
Buddleia salviaefolia Lam. : Saliehout; Wit-salie.
Burchellia bubalina Benth. and Hook : Buffelshoring; Wildegranaat.
capensis R.Br. : Sien *B. bubalina* Benth and Hook.
Burkea africana Hook : Sering; Wilde-sering.
Buxus Macowani Oliv. : Buig-my-nie; Afrikaanse Buksboom.
Calodendron capense Thunb. Wildekastaiing.
Calpurnia lasiogyne E. Mey. : Transvaalse Keur.
sylvatica E. Mey. : Transvaalse Keur.
Canthium Mundtiana Cham. et Schlecht : Klip-els; Kloofhout.
obovatum Klotz : Kwar.
ventosum L. : Bokdrol; Skaapdrolletjies.
Cassine croceum Kuntze : Saffraan.
sphaerophylla Kuntze : Kobobessie; Ghoeboebessie.
Castanea sativa Mill. : Kastaiing.
Catha edulis Forsk. : Boesmanstee; Spelonketee.
Cedrus-soorte : Cederbome.

atlantica Manetti : Atlas-ceder.
deodara Loud. : Deodar.
libanitica Trew. : Ceder van Libanon.
Celtis Kraussiana Bernh. : Kamdebo-stinkhout : Witstinkhout; Witgatboom; Onbekende Boom.
Chilianthus arboreus A. DC. : Salie; Wildevlier; Baster-olienhout.
Chrysophyllum magalismontanum Sond. : Stamvrugte.
Cinnamomum camphora T. Nees et Eberm. : Kanferboom.
Clausena inaequalis Btl. : Perdepis; Lemoenhout.
Combretum apiculatum Sond. : Rooibos.
glomeruliflorum var. *obscurum* Burtt Davy : Rooiblaar; Rooiblad.
glomeruliflorum var. *riparium* Burtt Davy : Rivier-vaderlandswilg.
imberbe Wawra. : var. *Petersii* Engl. Hardekool; Loodhout.
Kraussii Hochst. : Rooiblad; Rooiblaar; Bosvaderlandswilg.
rhodesiacum Bkr. : Kierieklapper; Steelboom.
Zeyheri Sond. : Rooibos; Raasbos; Niklaas-klapper; Warmkos.
Copaifera mopane Kirk : Mopanie.
Cordia abyssinica R.Br. : Grootblaar.
caffra Sond. : Ouhout; Septee.
Croton gratissimus Burch. : Boog.
Cryptocarya Liebertiana Engl. : Wildekweper.
Cunonia capensis Linn. : Rooi-els.
Cupressus-soorte : Cypresbome.
sempervirens var. *stricta* Ait. : Kerkhof-cypres.
Curtisia faginea Ait. : Asgaaihout : Asgaai.
Cussonia spicata Thunb. : Kiepersol; Sambreelboom; Nooiensboom; Waaiboom.
Dais cotinifolia L. : Kannabos.
Dichrostachys glomerata Hutch et Daly : Sekelbos.
Diospyros ebenum Koen : Ebbenhoutboom; Ebbehout; Ebbehoutboom.
mespiliformis Hochst. : Jakhalsbessie.
Dombeya rotundifolia Harv. : Drolpeer; Blombos; Dikbas.
Dovyalis caffra Warb. : Kei-appel.
rhamnoides Harv. : Suurbessies; Wynbessies.
rotundifolia Harv. : Sien *D. rhamnoides*.
tristis Sond. : Wilde-appelkoos.
Ehretia rigida (thunb.) Druce : Deurmekaar; Stamperhout.
Ekebergia capensis Sparrm. : Essenhout.
Erythrina caffra Thunb. : Kafferboom.
Humei E. Mey. : Natalse Kafferboom.
Eucalyptus-soorte. Gombome.
diversicolor F.v.M. : Karri.
globulus Labill. : Bloekomboom; Blougomboom.
marginata Smith : Jarra.
saligna Smith. Saligna-gomboom.
Euclea lanceolata E. Mey. : Bosghwarrie : Ghwarrie.
pseudebenus E. Mey. : Ebbenhoutboom; Ebbehout; Ebbehoutboom.
Eugenia Zeyheri Harv. : Wildejamboes.
Euphorbia Cooperi : Naboom.
grandidens : Naboom.
ingens : Naboom.
tetragona Haw. : Naboom.
Fagara capensis Thunb. : Perdepram; Wildekarmonk; Knoppiesdoring.
Davyi Verdoorn : Perdepram; Wildekarmonk; knoppiesdoring.
Fagus sylvaticus L. : Beuk; Beukeboom; Boekenhout.
Faurea Galpini Phillips : Rooiboekenhout.
Macnaughtonii Phillips : Terblans.
saligna Harv. : Swartboekenhout; Bosveldboekenhout; Rooiboekenhout; Transvaalse Boekenhout.
speciosa Welw. : Breeblaarboekenhout.
Ficus capensis Thunb. : Bosvy; Wildevyeboom.
natalensis Hochst. : Natou.
Pretoriae Burtt Davy : Wonderboom.
Fraxinus-soorte : Esbome.
Gardenia neuberia E. et Z. : Opgeitjies.
Rothmannia L. : Aapsekos; Aapkos; Apieskos; Bobbejaanappel; Bobbejaan-

appelbos; Kershout; Wildekatjiepiering; Kalbas; swarthout.
Thunbergia L.: Wildekatjiepiering; Buffelsbal; Stompdoring.
Gonioma Camassi Ecklon.: Kamassi.
Kamassi E. Mey.: Sien *G. Camassi* Ecklon.
Grewia occidentalis L.: Kruisbessie.
Greyia Sutherlandii Hook et Harv.: Baakhout.
Gymnasporia acuminata Szysz.: Sybas.
buxifolia Szysz.: Lemoendoring; Pendoring; Gifdoring.
deflexa Sprague: Transvaalse Saffraan.
pedunculatis L. Bolus: Swarthout.
Halleria lucida L.: Notsing; Notseng; Kinderbessie; Ouhout; Witolienhout; Wit-olyf.
Harpephyllum caffrum Bernh.: Kafferpruim; Suurpruim.
Hartogia capensis Thunb.: Lepelhout.
Heeria argenteum O. Ktze.: Kliphout.
paniculosa O. Ktze.: Harpuis; Rapuis; Respies.
Heteropyxis natalensis Harv.: Wildelaventel.
Hippobromus pauciflorus Radlk.: Baster-perdepis.
Ilex mitis Radlk.: Without; Waterhout; Witwaterhout.
Jacaranda mimosaefolia D. Don.; Sien *J. ovalifolia* R.Br.:
ovalifolia R.Br.: Jakaranda; Jacaranda.
Juglans regia L.: Okkerneut.
Juniperus communis L.: Jenewerboom.
Kirkia acuminata Oliv.: Wit-sering.
Wilmsii: Slaploot.
Lachnopylis congesta C. A. Smith: Wit-salie.
floribunda C. A. Smith: Vlier.
Lachnostylis capensis Turcz.: Koolhout.
Lannea discolor Engl.: Bakhout; Dikbas; Baster-maroela.
Leucodendron argenteum (L) R.Br.: Silwerboom; Witboom.
Leucosidea sericea E. et Z.: Ouhout; Oubos.
Leucospermum conocarpum R.Br.: Kreupelhout; Luisies; Goudboom.
Lonchocarpus Capassa Rolfe: Olifantsoor.
Loxostylis alata Spreng.: Teerhout; Tierhout.
Maba natalensis Harv.: Smalblaar.
Maerua caffra Sim: Witboom; Witbos; Witboshout; Withoutboom.
Maurocenia frangularia Mill.: Aasvoëlbessies.
Melia azedarach L.: Sering.
Mespilus germanica L.: Mispel (Europese).
Milletia caffra Meisn.: Oemsimbeet; Kaffer-ysterhout.
Mimusops obovata Sond.: Rooimelkhout; Moepel.
Zeyheri Sond.: Moepel; Rooimelkhout; Transvaalse Rooimelkhout.
Myoporum insulare R.Br.: Manitokka.
serratum R.Br.: Sien *M. insulare* R.Br.
Ochna arborea Burch.: Rooihout.
Holstii Engl.: Rooi-ysterhout; Rooihout.
O'Connori Phillips: Rooi-ysterhout.
pulchra Hook: Seerbos; Seermaak.
Ocotea bullata E. Mey.: Stinkhout; Swartstinkhout.
Olea africana Mill: Olienhout; Wilde-olyfboom; Oliewenhout; Olywenhout; Olynhout.
capensis L.: Ysterhout; Swart-ysterhout.
foveolata E. Mey.: Baster-ysterhout.
laurifolia Lam.: Swart-ysterhout; Ysterhout.
verrucosa Link.: Sien *O. africana* Mill.
Olinia cymosa Thunb.: Rooibessie; Hardepeer; Berghardepeer; Rooihout.
emarginata Burtt Davy: Rooibessie; Transvaalse Hardepeer.
Osyris abyssinica Hochst.: Bergbas; Pruimbas; Jakhalspruimbessies; Jakhalspruim; Bloupruim; Blaarbas.
Pappea capensis Eckl.: Bergpruim; Kaambessie; Pruimbessie; Wildepruim; Oliepitte; Wilde-amandel; Noupitjie; Noupitte.
Parinarium mobola Oliv.: Grysappelboom; Mobola; Mobola-pruim.
Peddiea africana Harv.: Sterkbas.
Peltophorum africanum Sond.: Huilbos; Huilboom; Dopperkiaat; Huilboerboon.
Phyllanthus discoideu Müll, Arg.: Egossa-rooipeer.

Pinus-soorte : Dennebome.
canariensis Ch. Smith : Kanariese Denneboom.
insignis Dougl. : Sien *P. radiata* Don.
maritima Lam. : Sien *P. pinaster* Ait.
patula Schl. et Cham. : Patula-den.
pinaster Ait. : Spar-den; Mannetjie-denneboom.
radiata Don : Insignis.
Pittosporum viridiflorum Sims : Bosboekenhout; Rooiboekenhout; Kasuur.
Platylophus trifoliatus Don : Wit-els.
Plectronia Mundtiana Pappe. Sien *Canthium Mundtianum* Cham. et Schlecht.
obovata Valeton : Sien *Canthium obovatum* Klotz.
Pleurostylia capensis Oliv. : Koffiepeer; Koffie-hardepeer; Hardepeer; Basterssaffraan.
Podocarpus-soorte : Geelhoutbome.
elongatus L'Her. ex Pers. : Breëriviergeelhout.
falcatus R.Br. ex Mirb. : Outenikwa-geelhout; Kalander; Kalander-geelhout; Baster-geelhout.
Henkelii Stapf. Henkel-geelhout.
latifolius R.Br. : Regte Geelhout; Opregte Geelhout; Regop-geelhout.
Populus-soorte : Populierbome.
canescens Smith : Vaalpopulier.
nigra var. *Italica* Du Roi : Italiaanse Populier.
Portulacaria afra Jacq. : Spekboom.
Protea grandiflora Linn. : Waboom.
Ptaeroxylon obliquum Radlk. : Nieshout.
Pterocarpus angolensis DC. : Kiaat; Transvaalse Kiaat; Greinhout; Lakboom; Lakhout.
rotundifolius Druce : Dopperkiaat; Blinkblaar.
Pterocelastrus tricuspidatus Sond. : Kershout.
Pygeum africanum Hook : Bitter-amandel; Nuwehout; Rooistinkhout.
Quercus-soorte : Eikebome.
robur L. : Eikeboom; Eik; Akkerboom.
suber L. : Kurk-eik.
Rapanea melanophleos (L) E. Mey. : Boekenhout; Witboekenhout.
Rauwolfia caffra Sond. : Kinineboom.
Rhamnus prinoides L'Her. : Blinkblaar.
Zeyheri Sond. : Rooilemoen; Rooi-ivoor; Rooihout.
Rhus Gueinzii Sond. : Baster-karee; Taaibos.
lancea L. : Kareeboom; Karee; Rooikaree; Soetkaree.
Legatii Schonl. : Bostaaibos; Kieriehout; Westelike Essenhout; Bosganna.
obovata Sond. : Taaibos.
pyroides Burch. : Taaibos.
Robinia pseudacacia L. : Akacia.
Royena lucida Linn. : Swartbas; Tolletjie.
pallens Thunb. : Bloubos; Swartbos.
Salix-soorte : Wilgerbome.
babylonica L. : Treurwilger; Wilgerboom; Wilgeboom.
capensis Thunb. : Wildewilgerboom; Rivierwilg.
Sambucus nigra L. : Vlier (Europese).
Schinus molle L. : Peperboom.
Schotia brachypetala Sond. : Boerboom; Hottentotsboerboon; Huilboerboon; Huilbos.
latifolia Jacq. : Bosboerboon; Boerboon.
speciosa Jacq. : Boerboon.
transvaalensis Rolfe : Transvaalse Boerboon.
Sclerocarya caffra Sond. : Maroela.
Scolopia Ecklonii Szysz. Rooipeer; Bergsaffraan.
Mundtii Warb. : Rooipeer; Bergsaffraan; Klipdoring.
Zeyheri Szysz. : Doringpeer; Hoenderspoor; Wolwedoring.
Scutia indica Brogn. : Sien *S. myrtina* Kurz.
myrtina Kurz. : Droog-my-keel; Wag-'n-bietjie; Katdoring; Dragies.
Securidaca longipedunculata Fres. : Krinkhout.
Sequoia gigantea Decsne. : Reuseboom.
Sideroxylon inerme Linn. : Witmelkhout; Melkhout; Jakhalsbessie.
Spirostachys africana Sond. : Tambotie.

Strychnos Atherstonei Harv. : Kiaat.
Henningsii Gilg. : Hardepeer.
pungens Solored. : Botterklapper.
Schumanniana Gilg. : Suurklapper.
Swietenia Mahogoni Jacq. : Mahonie.
Syringa vulgaris L. : Sering; Tuinsering.
Syzygium cordatum Hochst. : Waterbessie; Waterboom; Waterhout.
Gerrardii Hochst. : Waterpeer; Vaderlandswilg.
Tamarix articulata Vahl. : Abiekwas-geelhout.
Tarchonanthus camphoratus L. : Kanferhout; Supree; Sieriehout; Vaalbos; Wilde-salie; Veldvaalbos; Kanferbos.
Terminalia sericea Burch. : Vaalbos, Bosvaalbos.
Toxicadendron capense Thunb. : Gifboom; Wolweboontjie; Wolwegif; Boesmanskif.
Trema bracteolata Ficalho : Hophout.
Tricalysia lanceolata K. Schum. : Tolballie.
Trichilia emetica Vahl. : Essenhout; Rooi-essenhout; Natalse mahonie; Basteressenhout.
Trichocladus crinitus Pers. : Onderbos.
ellipticus E. et Z. : Onderbos.
grandiflorus Oliv. : Onderbos.
Trimeria grandiflora Warb. : Wilde-appel; Wilde-appelkos; Wilde-moerbei; Grootblaar-ysterhout.
Ulmus : Iep; Olm.
Vangueria infausta Burch. : Mispel; Wilde-mispel.
Vepris lanceolata G. Don : Wit-ysterhout.
Virgilia capensis Lam. : Sien *V. oroboides* Salter.
oroboides Salter : Keur; Keurtjie; Keurboom.
Widdringtonia cupressoides Endl. : Sapree; Bargsapree; Bergcypres; Bobbejaankers; Dupresknop.
juniperoides Endl. : Clanwilliamceder; Cederboom.
Whytei Rendle : Transvaalse Bergcypres.
Ximenia americana L. : Suurpruim; Wildepruim.
caffra Sond. : Suurpruim; Wildepruim.
Xymalos monospora Baill. : Lemoenhout; Borriehout.
Zizyphus mucronata Willd. : Blinkblaar-wag-'n-bietjie; Blinkblaar; Buffelsdoring; Haakdoring; Wag-'n-bietjie; Katdoring.

PUBLIKASIES WAARIN POPULAIRE BOOMNAME AANGEGEE WORD

1. J. BURTT DAVY : Manual of the Flowering Plants and Ferns of the Transvaal with Swaziland, South Africa. Part I and II. Longmans, Green & Co. 1926 and 1932.
2. E. E. GALPIN : The Native Timber Trees of the Springbok Flats. Bot. Survey of S.A. Mem. No. 7, Pretoria, 1924.
3. R. MARLOTH : The Flora of South Africa, Vol. I-IV. 1913, 1915, 1925, 1932.
4. ———— : The Common Names of Plants, Cape Town, 1917.
5. H. M. MCKAY : The Index to the Aboriginal, African and Dutch Names of the Plants of Southern Africa. With references to the Plantarum Africae et Extratropicae by W. J. Burchell, compiled in the years from 1810 till 1815. *The Journal of S.A. Botany*. Vol. IV Part IV. 1938.
6. T. R. SIM : The Forests and Forest Flora of the Cape Colony. 1907.
7. ———— : Native Timbers of South Africa. Department of Mines and Industries. Mem. No. 3, Pretoria, 1921.
8. J. M. WATT and M. G. BREYER-BRANDWYK : The Medicinal and Poisonous Plants of Southern Africa. E. and S. Livingstone, Edinburgh, 1932.
9. Algemene lys van Gereserveerde Bome. Regeringskennisgewing No. 594 van die 11de Mei, 1934.

FIBRIL BEHAVIOUR AS DISCLOSED BY SHRINKAGE OBSERVATIONS

By JOHN M. TURNBULL

(*Timber Mechanics Officer, Forest Products Institute.*)

1. Material Used in Investigation

THE phenomena described in this paper were revealed by measurements taken green, air dry, and oven dry, on 154 weighed specimens of *Pinus patula* timber. The specimens were cut from 8 inch transverse slices sawn at top and bottom of the 2 inch radial butt flitches of thirteen 25 year old stems felled September, 1939, at Cedara Plantation, near Pietermaritzburg. Each slice was subdivided radially into six specimens, three each side of the pith, their radial thicknesses ranging from ½ to 3 inches, according to rate of growth, so as to secure a comparable number of years' growth at each radial position.

2. Consistency of Values

Investigation was concentrated on the longitudinal-transverse shrinkage ratio of the specimens, and in a study of so anisotropic a material as wood, it is desirable to husband all relative data to the best possible advantage. It has been found, in the present investigation, that the sum of the radial and tangential percentage shrinkages has a slightly lower mean deviation than either of the independent linear percentages, and is a very close approximation to percentage superficial transverse shrinkage. The maximum, minimum, and average errors in the approximation are respectively four, two, and three per cent. The maximum disproportion is only two, which is beyond the standard of precision adopted in taking the transverse measurements. The sum of percentage shrinkage in the two directions may therefore be regarded as being proportional to superficial transverse shrinkage per cent., and in view of the low absolute error involved, is accepted as its equivalent throughout this paper.

The longitudinal-transverse shrinkage ratios of all specimens from green to air dry and from green to oven dry were computed with radial, tangential, and superficial shrinkage as denominator, and the resulting

TABLE I.

Average mean per cent. deviation of longitudinal-transverse shrinkage ratio for seventeen weight classes

Drying Range	Average mean per cent. deviation on basis of undermentioned denominators		
	Radial	Tangential	Superficial
Green to air dry	19.3	12.8	12.3
Green to oven dry	15.8	11.1	10.8

values assembled in the oven-dry-weight-per-cubic-foot classes 20 to 36. The average values of the mean per cent. deviations of all classes are reflected in table I. A deviation of zero would justify investigation on the basis of a single sample. The table shows that as compared with investigation on the basis of radial shrinkage, green to air dry, selection of superficial shrinkage, green to oven dry, as denominator in the ratio, has the effect of roughly doubling the number of samples available. The difference between tangential and superficial shrinkage, green to oven dry, is only three per cent. but as adoption of the latter has the effect of adding nearly five specimens to the 154 actually available, it has been adopted as denominator in the longitudinal-transverse shrinkage ratio, hereinafter referred to as ratio a.

TABLE II.

RATIO BETWEEN LINEAR AND SUPERFICIAL TRANSVERSE SHRINKAGE IN 16 WEIGHT CLASSES.

Weight Class	Number of Tests	Average Shrinkage				
		Superficial	Linear		Percentage of superficial	
			Tangential	Radial	Tangential	Radial
20.8	3	9.0	5.4	3.6	60	40
21.8	5	8.5	5.0	3.5	59	41
22.4	8	11.0	6.4	4.6	58	42
23.3	15	10.2	6.3	3.9	62	38
24.5	14	10.8	6.6	4.2	61	39
25.4	7	10.8	6.4	4.4	59	41
26.4	8	11.6	6.9	4.7	60	40
27.5	8	11.1	6.6	4.5	60	40
28.4	16	12.7	7.7	5.0	61	39
29.4	14	11.9	7.3	4.6	61	39
30.5	11	11.5	7.2	4.3	63	37
31.4	15	12.1	7.3	4.8	60	40
32.6	7	12.4	7.4	5.0	60	40
33.4	8	11.9	7.4	4.5	62	38
34.6	3	11.6	7.0	4.6	60	40
35.1	9	12.2	7.4	4.8	61	39
Mean					60	40

The tendency towards constancy in the ratio between linear and superficial transverse shrinkage, green to oven dry, as will be seen from table II, is so marked that superficial ratio a may, if desired, be converted to a linear ratio by applying the average percentages indicated in columns 6 and 7 thereof. Thus, the longitudinal-tangential and longitudinal-radial shrinkage ratios will equal 1/.6 and 1/.4 per cent., respectively, of ratio a. The mean deviation of the values in column 6, it might be noted, does not exceed 1.7 per cent.

3. EFFECT OF DRYING

Having adopted a superficial ratio a, its values in drying the specimens from green to air and oven dry were compared. It was found that at the oven dry stage it averaged 2.36 times that at air dry. In only five out of the 154 specimens was it at oven dry less than at air dry. In two other instances it was equal. Frequencies in integral classes were as reflected in table III,

TABLE III.

RATIO BETWEEN RATIO A AT OVEN DRY AND AIR DRY IN FREQUENCY CLASSES.

Class	Frequency
0 to 1	5
1 to 2	64
2 to 3	52
3 to 4	17
4 to 5	10
5 to 6	6

The average increase and the frequency table together indicate that in drying from equilibrium down to a moisture content of nil, ratio a, in general, tends to rather more than double. Before attempting to correlate this increase with any familiar phenomenon, a brief description of the mechanics of shrinkage seems appropriate here.

Linear, superficial, or volumetric movement in wood is the aggregate effect of movement in its individual fibres. Each fibre consists (1) of a lumen surrounded by a mass of longitudinal fibrils running roughly parallel to the axis of the fibre. The longitudinal fibrillar mass is coated on either side with a relatively very narrow zone of fibrils assuming the form of a flat spiral, and the whole coated externally with a thin layer of largely non-cellulosic material threaded irregularly with extremely thin cellulose fibrils. In the course of drying, until the lumen becomes drained of all moisture, no mechanical reaction in the fibrillar mass occurs, the fibrils until then being held apart by a constant outward flow of moisture. When the lumen is emptied, however, the fibrillar mass, having no longer any reservoir to draw upon, gradually yields to the stream the moisture occupying its interfibrillar spaces, the individual fibrils closing in on each other to occupy the vacated space. It is this closing in of the fibrils that causes the reduction in volume known as shrinkage. So long as the fibrils assume a position parallel with the axis of the fibre, shrinkage in the fibre will be in a horizontal plane only. If inclined to the axis, however, their absolute lateral movement will be effective in two inversely related component directions : one vertical, and the other horizontal, the ratio between them equalling the tangent of the angle of inclination from the vertical. In other words, the ratio between longitudinal and transverse shrinkage in individual fibres is determined by that angle. The position is illustrated very diagramatically in figure 1.

As far as is known to the writer, it has not yet been established to what extent movement in the flatly spiral fibrillar windings on the inner and outer boundaries of the secondary walls and in the largely non-cellulosic primary walls of fibres affect movement in the longitudinal fibrillar mass, nor even the extent to which aggregate movement in individual fibres is reflected in the aggregate movement of masses of tissue. The fibrils in the outer windings are extremely thin, and consist of relatively few layers. Microscopical observation has revealed bursts (2) in the outer cellulosic winding of the secondary wall caused by pressure from within by the longitudinal mass, which balloons out between the constricted nodes of the outer winding. This suggests

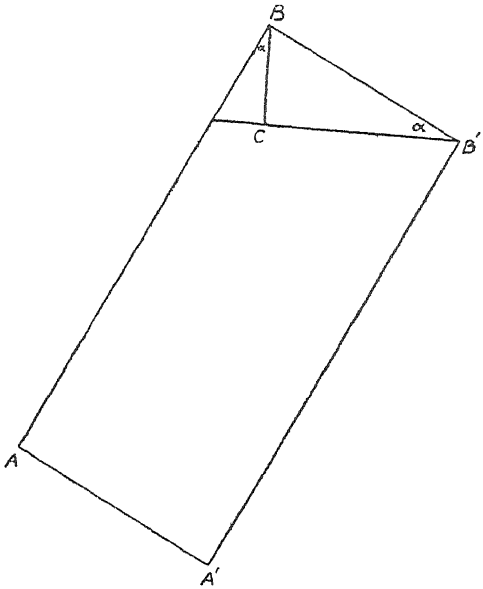


FIG. 1.—RESOLUTION OF LATERAL FIBRIL MOVEMENT INTO EFFECTIVE COMPONENTS. AB, fibril. A'B', same fibril after moving laterally through distance BB'. Angle α, inclination of fibril from vertical axis BC. BC, vertical component. B'C, horizontal component.

that the strength of the fibre is determined predominantly by the longitudinal fibrillar mass, which may accordingly be assumed to be the principal contributor to aggregate movement and fibril inclination in individual fibres. If movement in masses of tissue faithfully reflects aggregate movement in individual fibres, this must be so, because, even in extreme cases, the ratio born by longitudinal to transverse shrinkage is extremely low, thus indicating steep fibril pitch. In the 154 specimens of *Pinus patula* on which these observations are based, the superficial ratio, in drying from green to oven dry, ranged between .005 and .09, averaging .021. Assuming these ratios actually do reflect the tangent of fibril inclination, the corresponding inclinations would be as shown in table IV, which are far too low for association with the

TABLE IV.

FIBRIL INCLINATION CORRESPONDING TO MAXIMUM, MINIMUM AND AVERAGE RATIO A.

Ratio α	Angle of fibril inclination on basis of undermentioned ratio denominators		
	Superficial	Linear	
		Tangential	Radial
.005	0° 20′	0° 30′	0° 50′
.090	5° 10′	8° 40′	13° 0′
.021	1° 10′	2° 0′	3° 0′

lateral movement of coils in a flat spiral. On the other hand, the low values are quite compatible with the verified conception of the main zone of the secondary wall. Granted that the ratio does reflect fibril inclination in this zone, the fact that it roughly doubles in drying from equilibrium to oven dry indicates a corresponding increase in values for that expression, as small angles and their tangents are very closely proportionate. Such an increase in inclination can be induced only by a twisting of the fibres, commencing, presumably, at fibre saturation point. As indicated by the figures in table IV, the twist is very slight, otherwise it would be difficult to conceive how they could twist against each other. Such a twist, however, slight as it may be, suggests association with two familiar phenomena. Firstly the setting up of interfibral cleavage planes of low resistance, along which checking may originate; and secondly, enhancement of fibre strength in drying as reflected in the well-known strength-moisture relationship in wood.

4. Ratio A in Eccentric Stems

As the stems were elliptical in cross-section, the oven dry ratios in the outer thirteen to seventeen annual rings at opposite orientations were compared. The data is shown in table V, from which it will be seen that the higher values occurred along the longer radii. The

TABLE V.

Oven dry ratio A at opposite sides of radial flitches.

Tree Number	Rings Included	Ratio α along undermentioned radii			
		Butt portion		At 12 feet up	
		Long	Short	Long	Short
1	14	.016	.011	.022	.017
2	12	.017	.017	.033	.012
3	14	.018	.017	.018	.026
4	16	.023	.017	.025	.012
5	15	.015	.013	.028	.011
6	14	.054	.014	.068	.011
7	13	.017	.014	.014	.014
8	14	.023	.012	.017	.009
9	14	.014	.018	.015	.013
10	17	.014	.011	.017	.015
11	17	.010	.009	.013	.006
12	17	.007	.009	.020	.019
13	15	.075	.011	.026	.014
Mean		.0233	.0133	.0243	.0138
Short/Long ratio		.57		.57	

equality of the ratio (.57) between the mean values on either side of the flitches at both low and high cuts suggests a tendency towards constancy: that is, that in any stem the relationship between ratio α in wood of a given year at opposite orientations will be fixed. It is not considered that the higher values on the fast growing side are causally associated with rapid growth, as no such trend is discernible in comparing values in rapid and slow growing stems. It would seem to be more consonant with an established tendency for pressure wood to develop on the rapidly growing side of stems (3). High longitudinal shrinkage invariably occurs in pressure wood (4).

5. The Drying of Spiral Grained Wood

Misra (5), working with *Pinus longifolia*, has established the enhancement of values along the longer radius by direct observation, and opens up an interesting field of research by suggesting that "the pitch of the cellulose micelles in the tracheides . . . . shows significant correlation with (the) phenomenon of spiral grain." In this latter connection it might here be observed that the fibrils in tissue composed of inclined fibres, such as those resulting from spiral growth, altogether independently of their own inclination to the fibre axis, are so disposed as to facilitate effective movement in two component directions, for although the fibrils themselves may be parallel to the fibre axis, they more often than not will be inclined to the axis of the stem. If clockwise inclined in individual fibres, the inclination in a given direction from the stem axis would be exaggerated, and a high ratio a might be expected. An anti-clockwise inclination on the other hand would tend to reduce the ratio, and when fibrils inclining in this direction assume a position parallel to the stem axis, the tendency to movement in a longitudinal direction would be completely neutralised.

A more direct avenue of approach to the subject of spirality has been suggested to me by Mr. P. J. A. Loseby, of the Forest Products Institute, who points out that spiral grained pine poles, contrary to a generally accepted view, tend to untwist during the course of drying out. This has, in fact, been confirmed by actual demonstration on *Pinus canariensis* at Pretoria West. Loseby further contends and demonstrates that when a rope composed of strands in which the individual fibres are aligned parallel to their axis, is untwisted, the component strands tend to twist in a direction opposite to the original direction of twist of the rope itself. Without going into the mechanics of this behaviour, the reader may easily satisfy himself regarding the truth of the assertion by carrying out simple twisting experiments on short lengths of rope or cord. Now, if the untwisting of a cord results in the twisting in another direction of its component strands, it is reasonable to expect a twist in the main body to relax when the strands are individually twisted in that direction. This conception seems to be applicable to the untwisting of spiral grained poles during drying. The wood fibres represent the component strands of a rope, and the inception of a twist in them suggested by an observed increase in ratio a may be regarded as conducive to a relaxation of the torsional stress in the main tissue. On the hypothesis that individual fibres do not commence to twist until their lumens are depleted of moisture, this suggestion further indicates that twist in individual fibres assumes invariably a direction opposite to that of any twisted pine pole.

6. Influence of Density

A comparison of the mean ratio a of all specimens of each of the three radial positions with the mean of the corresponding oven dry weight per cubic foot, as reflected in table VI, discloses a distinct inverse association between the two phenomena. The low deviation between their products in the three positions indicates the closeness of the association. Close as it is it cannot be inferred that it is causal. If it were, the relationship would hold in any radial position.

TABLE VI.

COMPARISON OF RATIO A AND OVEN DRY UNIT WEIGHT IN THREE RADIAL POSITIONS

Property	Mean value in undermentioned radial positions		
	Outer	Intermediate	Inner
Weight per cu. ft. ..	32.53	29.68	23.82
Ratio α	.0181	.0189	.0241
Product of foregoing ..	.59	.56	.57

In order to ascertain whether the association holds in such circumstances, values for ratio α, unit weight, and superficial transverse shrinkage for the thirteen stems were assembled with reference to each radial and vertical position, thus yielding for each property thirteen values in each of twelve positional series. For the purpose of table VII, in which the relevant correlation coefficients are reflected, the positions were numbered and lettered as follows:—

A	B	C	c	b	a
1	2	3	6	5	4

Butt

D	E	F	f	e	d
7	8	9	12	11	10

12 ft. up

TABLE VII

COEFFICIENTS OR CORRELATION BETWEEN RATIO A (A), UNIT WEIGHT (B), AND SUPERFICIAL TRANSVERSE SHRINKAGE

Position		Number Speci-mens	Correlation Coefficients			Remarks
No.	Letter		A/B	A/C	B/C	
1	A	13	+0.104	—0.960	—0.168	Butt Fast growing
2	B	,,	—0.377	—0.817	+0.126	, ,, ,, side
3	C	12	—0.483	—0.647	+0.570	,, ,, ,, ,,
4	a	13	+0.104	—0.442	+0.030	,, Slow ,, ,,
5	b	,,	—0.285	—0.026	+0.182	,, ,, ,, ,,
6	c	,,	—0.435	—0.672	—0.011	,, ,, ,, ,,
7	D	,,	—0.190	—0.551	—0.158	Top Fast ,, ,,
8	E	,,	+0.015	—0.683	—0.025	,, ,, ,, ,,
9	F	,,	+0.343	—0.560	—0.091	,, ,, ,, ,,
10	d	,,	+0.222	+0.044	+0.106	,, Slow ,, ,,
11	e	,,	+0.076	—0.229	+0.371	,, ,, ,, ,,
12	f	12	—0.288	—0.139	+0.469	,, ,, ,, ,,

As will be seen from the table, the correlation between ratio α and weight never attains significance, and is, moreover, markedly erratic. The direct correlation between weight and superficial transverse shrinkage reaches a higher maximum, but is still generally low. The inverse correlation between ratio α and superficial transverse shrinkage in positions 1, 2, 3, 6 and 8, on the other hand, falls well above the significant minimum, and in a few others it may be regarded as marginal. It would seem therefore that the weight and superficial transverse shrinkage relationship with ratio α is merely coincidental. Ratio α, and consequently fibril inclination, is undoubtedly and significantly correlated with superficial transverse shrinkage, whereas the rough correlation between ration α and unit weight, which is found in certain groupings, is due merely to an independent tendency in their respective

values to increase centrifugally. The tendency in transverse shrinkage itself to vary with weight, as shown in table II, also disappears when values are assembled with reference to each radial position. Beyer (6) and Greenhill (7) arrived at similar conclusions.

The higher correlations between ratio a and superficial transverse shrinkage on the fast growing side and in butt slices is doubtless attributable to the higher range of longitudinal shrinkage values that occurs along the longer radii of eccentric stems, and along butt radii, which traverse a greater number of annual rings than those higher up the stem. In other positions small but significant differences in longitudinal shrinkage are often beyond the precision of ordinary micrometer measurement.

7. Saturated Moisture Gradient

That ratio a varies inversely with some so far unidentified function of transverse shrinkage, or the converse, seems obvious from the data presented in table VIII and the continuous curve shown in figure 2, which has been plotted on the data presented in the second and fourth columns thereof.

Granted that ratio a reflects fibril inclination, the increasing differences between the successive figures in the fourth and fifth columns

TABLE VIII

Ratio A in successive groups of superficial transverse shrinkage

Number of specimens in group	Average shrinkage value of group		Corresponding ratio a		
	Superficial transverse	Longitudinal	Actual	Converted*	Difference
4	6.1	.462	.077	.077	0
4	7.4	.380	.051	.062	11
10	8.4	.342	.041	.056	15
19	9.5	.259	.027	.042	15
24	10.5	.199	.019	.033	15
25	11.5	.196	.017	.032	14
37	12.5	.187	.015	.031	19
23	13.4	.179	.013	.030	17
13	14.9	.187	.012	.031	16

of Table viii indicate that absolute lateral fibril movement, as well as transverse shrinkage, varies inversely with fibril inclination. These two columns are both based on horizontal fibril movement, but the correspondent angles are so small that such movement for practical purposes may be considered as being proportional to absolute lateral movement. In the fifth column ratio a has been computed with a constant denominator of 6.1, that is, on the assumption that absolute lateral movement does not deviate from that initial magnitude. The preceding column reflects actual ratios, and it will be seen from the final column of the table that the differences between the two increase with decrease in actual ratio. The trend of the divergence is indicated by the broken and unbroken curves in figure 2. Although it is unlikely that both curves have a common origin, a ratio of .077 and a transverse shrinkage of 6.1, as being extreme points in an established series, have been adopted as origin also of the theoretical series in order

*To a constant denominator of 6.1

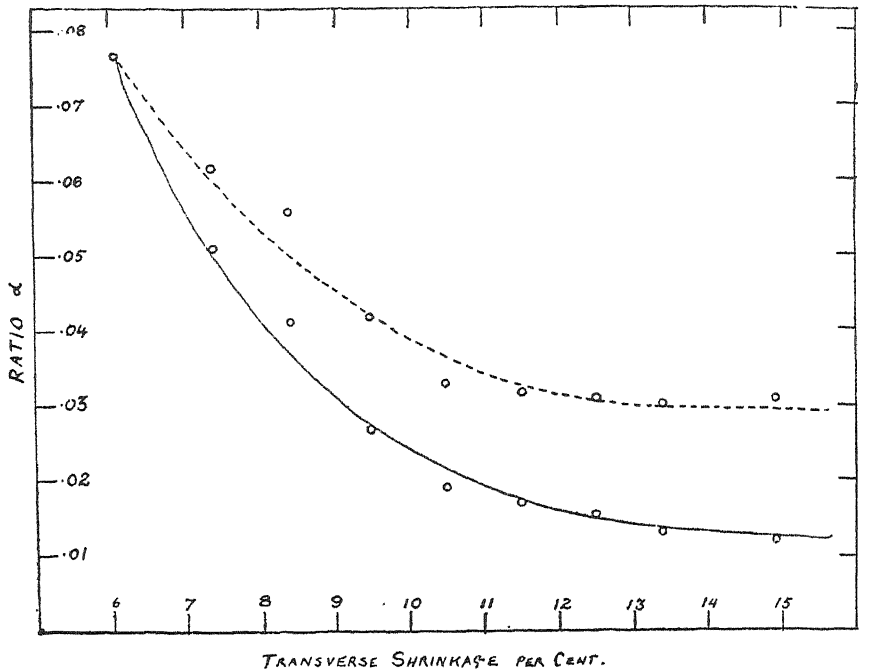


FIG. 2.—FIBRIL CONTROL OF MOISTURE GRADIENT
Continuous curve represents actual values, and broken curve, actual values converted to basis of constant absolute lateral fibril movement.

conveniently to illustrate a hypothesis. Whatever the absolute vertical displacement between the two origins, the vertical distance between the curves at any point is a relative measure of variation in absolute fibril movement in response to variations in fibril inclination. As, again, fibril inclination decreases centrifugally in the stem, the divergence of the curves indicates a centrifugal increase in absolute lateral fibril movement. In other words, the further outward in the stem from the pith, the greater will be the interfibrillar space of the fibres before the twist referred to at the end of section 3 commences, i.e., at fibre saturation or at any higher moisture content. Increasing interfibrillar space means augmented capacity for moisture accommodation, and hence the space between the two curves would seem to reflect the saturated moisture gradient of the stems investigated. If this surmise is eventually proved to be correct, it would furnish a feasible conception of the mechanism whereby the rate of transpiration at any radial point is controlled, although it might still remain a moot point as to whether fibril pitch is determined cambially or later by degree of functional activity.

7. INTERNAL STRESSES

The conception of an increase in transverse fibril interval in successively formed incremental layers is suggestive of an associated

progression in fibre compression. The fibrils in green wood may be likened to the fingers of the hands when cupped over each other with the tip of each finger of the one resting on that of the corresponding finger of the other. When the fingers in this position are pressed against each other, the joined pairs splay out, and the interval between them widens. If the position is truly analogous, the progressive widening of the interfibrillar interval from pith to periphery might be attributed to an associated radial stress gradient. Jacobs (8) has developed a most ingenious technique for measuring the longitudinal movement of strips of wood caused by sudden release from stresses imposed within eucalypt stems, and has demonstrated indisputably that the outer layers in the living stem are in a state of tension, and the inner ones compressed. It would seem from the preceding section that the individual fibres, at least in pines, are subjected to stress in an opposite progression. This does not necessarily invalidate the hypothesis now advanced, because the incidence of applied stresses in individual fibres on masses of tissue may reflect a highly involved reaction between stressed fibres rather than the stresses directly imposed on individual fibres. The manifestation during conversion operations of internal stresses in freshly felled pine stems is negligible when compared with the behaviour of eucalypts. Conifers react to certain stimuli contrary to the reaction of hardwoods, and it is just possible that this may be another respect in which the wood of these two groups react conversely.

Summary

Shrinkage measurements taken on specimens of *Pinus patula* disclose a close inverse relationship between longitudinal and transverse shrinkage, indicating that their ratio is a function of fibril inclination. The ratio, in drying from air dry to oven dry, is found to double, thus suggesting a slight independent twisting in individual fibres, the implications of which in connection with spiral growth are discussed. A relatively high ratio along the longer radii of eccentric stems, it is contended, is associated with a tendency for pressure wood to develop on the side of stimulated growth. Density appears to exert no direct influence on the ratio. An analysis of the basic data is used in an attempt to explain how the moisture gradient across stems at fibre saturation point is controlled. A suggested association between internal stress variations and fibril behaviour is also discussed.

Acknowledgements

The theory of the twisting of individual fibres during the course of drying, advanced in section 3, was adumbrated by my colleague Mr. M. H. Scott, to whom I am further indebted for access to material and data. In a report on an independent aspect of these shrinkages, Mr. Scott remarks, "it would appear that the longitudinal shrinkage to 9 per cent. moisture is less than one third of the total to oven dry, while transverse shrinkage to the same content is two-thirds." The data, which involved the irksome task of taking over 1,500 individual micrometer measurements and making innumerable computations, were derived and assembled for Mr. Scott's investigation by Mr. J. Jay, of the Forest Products Institute. I have to record my gratitude also to

Mr. N. B. Eckbo, Chief Forest Products Officer, for reading my manuscript through and offering various suggestions which have been duly adopted, and to Mr. E. K. Marsh, Research Officer in the Division of Forestry, for furnishing the correlation coefficients for table VII.

References

1. Clarke, S. H: Fine Structure of the Plant Cell Wall. *Nature*, 142/3603, 19.11.1938.

2. Hock, C. W., and William Seifriz: Microdissection of Paper Pulp Fibers. *Paper Trade Journal*, 110/5, 1.2.1940.

3. Büsgen < Münch < Thompson: The Structure and Life of Forest Trees. London, Chapman & Hall, 1929. P. 174.

4. Koehler, Arthur: Rapid Growth Hazards Usefulness of Southern Pine. *Journal of Forestry*, 36/2, February, 1938.

5. Misra, P.: Observations on Spiral Grain in the Wood of *Pinus longifolia*. *Forestry*, xiii/2, 1939.

6. Beyer, F. K.: Thesis Submitted for the Degree of Master of Science, University of Wisconsin, 1930 (Cited by Greenhill.)

7. Greenhill, W. L.: The Shrinkage of Australian Timbers. Pt. i. Council for Scientific and Industrial Research, pflt. No. 67. Melbourne, 1936.

8. Jacobs, M. R.: Further Studies on Fibre Tension. Commonwealth Forestry Bureau Bulletin No. 24. Canberra, 1939.



Forest Drive, Pinelands.

RECLAMATION OF THE CAPE FLATS
AN ARBOR DAY ADDRESS

[The address that follows was delivered at the opening of the Arbor Day celebrations (24 May) this year, at Pinelands, Cape, by Mr. J. J. Kotze, Conservator of Forests for the Western Cape Province, who planted the first tree.]

When your Chairman* asked me to officiate here to-day I thanked him and said I much appreciated the honour, but I suggested to him that one of Cape Town's Public Men would fit the role to better advantage. I had in mind some such notability as the Mayor. You will recollect he was kind enough to do so last year. You may not know it was at my suggestion he was approached. This year Mr. Bowes insisted that I should do so.

It is not that I do not agree it is most appropriate for the local Conservator of Forests, that is, the Government Official charged with the administration of the Forest Estate of the Western Cape Province, to officiate at such a laudable ceremony as treeplanting. My diffidence arose through a personal, innate dislike of publicity and the making of speeches. I recognise, however, that in asking me to be present here to-day your Association is honouring a Department which, on account of its creative works, deserves well of the Nation in general and of Pinelands in particular.

Where to-day a garden township has assumed shape, some 60 years ago a waste of sand, some of it in active drift before the relentless urge of the summer south-easters, existed. Such was the condition of the land we stand on when the Forest Department stepped into the breach and commenced its long-range project of making it habitable.

In the parts of the Cape Flats nearer the shores of False Bay reclamation by means of the planting of Marram grass commenced. Once the grass is established, indigenous shrubs and other plants, such as the Waxberry, are not slow to make their appearance, and the succession is hastened by artificially sowing seeds of those species. But the plants which have been of greater use than any in stabilising the sands, once they have been fixed, are Australian Wattles, the Rooikrans and Port Jackson Willow. These two trees in the course of time took almost complete possession of the sandy wastes. To-day they may be looked upon by some as noxious weeds, but the important role they have played in reclaiming the soil they grow on must not be lost sight of.

In those parts further from the shores of False Bay, such as at Uitvlugt and Epping where to-day the Garden Suburbs of Pinelands and of Epping exist, it was soon possible to establish a covering of more useful trees. Of the kinds tried none has succeeded so well as *Pinus pinaster,* the tree you see all around you.

I bring this historical background to your notice to-day as it is appropriate and fitting to dwell on it at a treeplanting festival at Pinelands—a festival made possible by the earlier planting of trees.

*Mr. J. H. Bowes, Chairman Pinelands Civic Association.

It should also serve as an object lesson of the great utility of trees quite apart from the commercial uses to which the wood they produce is put.

The planting of a tree, and especially ones such as are to be planted to-day for aesthetic purposes, is something to be proud of. All of you who are to do so will go home with a feeling of pride and a sense of having done something worth while. Provided it is well planted, it is suited to the locality and is well-cared for, a tree endureth, if not for ever, then for well beyond your allotted span of years. In the words of Sir Walter Scott "Ye may be aye sticking in a tree. It will be growing when ye're sleeping," and, he might have added, after you have passed on.

In a world such as we live in to-day, ravaged by the brute forces of destruction, it is good to be able to reflect that you have done something constructive and something to be proud of. May it inspire you with a greater love for Nature and for trees in particular.

In conclusion I wish to thank you for the honour you have done me and my profession in inviting me to officiate at this very pleasant and, may I hope, inspiring function. Long may the trees thrive as memorials to their youthful planters.

A STANDARD NOMENCLATURE FOR SOUTH AFRICAN GROWN TIMBERS

STANDAARD BENAMINGE VIR HOUTSOORTE IN SUID-AFRIKA GEKWEEK

AT the request of the Chairman of the Timber Sub-Committee of the South African Standards Institution, we print below draft proposals for a Standard Nomenclature for South African grown timbers. We do so gladly particularly as an article on Afrikaanse Bosboomname in this issue will tend to heighten its interest by providing opportunity for comparison. We are informed by the Chairman that his list of names at this stage is purely tentative, and that considered suggestions for its improvement will be gratefully received. The compiling of such a list is fraught with difficulty. First of all there is the question of the language in which the standard names should appear. The ideal in a trade nomenclature is one species, one standard name, though its adoption would hardly conform to the cultural requirements of a bilingual community. Standard names should so far as practicable be selected from names in common current use. If these were invariably already well established in both official languages, the compilation of a bilingual nomenclature would be simple. Unfortunately this is not the rule, and the compilers of the list have accordingly attempted to overcome the difficulty in certain instances by literal translation. This smacks of imposition of common names rather than selection of existing ones. In some instances one name is retained for both languages, as in knoppiesdoring, saffraan, and kiaat. These names have long been incorporated in the English vocabulary in South Africa and no change so far as they are concerned would be welcomed. Complications arise with the adoption of Bantu names. Phonetic representation of these in the two official languages differs, so that any attempt to overcome the difficulty of English and Afrikaans equivalents by recourse to a neutral language would be frustrated from the start.

OP versoek van die Voorsitter van die Sub-komitee vir Hout van die Suid-Afrikaanse Standaarde-Inrigting, gee ons hieronder voorlopige voorstelle vir standaard benaminge van houtsoorte in Suid-Afrika gekweek. Ons doen dit graag, veral daar 'n artikel oor Afrikaanse Bosboomname wat in hierdie uitgawe verskyn meer belangstelling sal aanvoer deur om geleentheid vir vergelyking aan te bied. Dit is ons meedeel dat die naamlys op hierdie stadium as tentatief beskou moet word, en dat voorstelle vir verbeterings graag ontvang sal word. Daar is verskeie moeilikhede verbonde aan die opstel van so'n lys, die vernaamlikste waarvan met die vraag van die geskikste taal wat vir elke soort gebruik mag word te doen het. Die ideale naamlys vir die handel sou wees een houtsoort-een standaard naam, dog die aanvaarding daarvan sal nouliks in ooreenstemming gebring kan word met die kulturele eise van 'n tweetalige gemeenskap. Standaard name moet sover moontlik gekies word uit die wat algemeen gebruiklik is. As hulle deurgaans reeds goed ingeburger is in albei offisiële tale, sou die samestelling van tweetalige benaminge eenvoudig gewees het. Ongelukkig is dit nie die geval nie en die samestellers van die lys het gevolglik probeer om die moeilikheid in sekere gevalle deur woordelike vertaling uit die weg te ruim. Dit smaak egter meer na die voorskrywing van gewone name as na die uitkies uit bestaande name. In sommige gevalle is een naam vir albei tale behou, soos byvoorbeeld knoppiesdoring, saffraan en kiaat. Hierdie name is reeds lankal in die woordeskat van Engelssprekende Suid-Afrikaners ingelyf, en geen verandering sover dit hulle betref, sal byval vind nie. Daar ontstaan verwikkelinge in verband met die opneem van Bantoename. Daar die fonetiese spelling van sulke name in die twee offisiële tale verskil, word enige poging om van die moeilikheid

Most of the standard names suggested for the exotic species are mere repetitions of the botanical specific name followed by the common generic name. Exceptions are made in the case of certain very familiar names, and it is difficult to conceive why this liberality has not been extended to the time-honoured use in South Africa of the name "cluster pine."

The compilation of separate lists for indigenous and exotic species seems to serve no useful purpose. We should like to see in the eventual list both groups included in one alphabet. A column might be provided for natural habitat.

As the list or lists are primarily for the guidance of consumers, and in view of what is laid down in the preamble under "Object," it is thought that standard names should precede botanical names in the ultimately approved draft, although a supplementary key list compiled under botanical names might be included to complete the picture.

A standard nomenclature for the purpose in view is very necessary, and no matter how much the eventual list may differ from the one that follows, its compilers are to be congratulated for providing a basis on which to work. One thing is certain. No list will please everybody, and for the sake of convenience all interested must be prepared to concede some cherished predeliction to the common cause.

When an eventual draft nomenclature is adopted by the Standards Institution adherence thereto in contracts, specifications, and inventories, where contemplated, might be indicated by inclusion of a special clause to that effect.

Suggestions should be addressed to the Chairman, Timber Sub-Committee, South African Standards Institution, P.O. Box 727, Pretoria, or to the Hon. Secretary of the Sub-committee, Roads Branch, City Hall, Johannesburg.

The draft nomenclature follows overleaf.

Die meeste standaard benaminge verbonde aan die gebruik van Engelse en Afrikaanse standaard name deur toevlug aan 'n neutrale taal te oorkom van die stanspoor af verydel. wat vir die uitheemse soorte voorgestel word, is blote herhalings van die botaniese soortnaam met die gewone geslagsnaam daaragter aangeheg. Uitsonderings word gemaak in die geval van sekere baie bekende name, en dit is moeilik om te verstaan waarom dieselfde gulhartige behandeling nie aan die ou bekende naam „cluster"-den, wat in Suid-Afrika algemeen bekend staan, toegeken word nie.

Dit skyn asof die opstel van aparte naamlyste vir inheemse en uitheemse soorte aan geen nuttige doel beantwoord nie. In die finale lys sal ons graag albei groepe in een alfabetiese lys ingesluit wil sien. Voorsiening kan gemaak word vir 'n kolom vir natuurlike groeiplekke.

Daar die lys of lyste in die eerste plek as leidraad vir verbruikers bedoel is en met die oog op wat in die inleiding onder "Doel" gesê word, word dit gemeen dat die botaniese name deur die standaard name voorafgegaan moet word. 'n Sleutellys van botaniese name en hulle standaard ekwivalente kan wel volledigheidshalwe aangeheg word.

'n Lys van standaard benaminge wat aan die vooropgestelde doel sal beantwoord is uiters noodsaklik, en afgesien van hoeveel die finaal goedgekeurde lys van die wat nou volg mag verskil, moet die opstellers daarvan gelukgewens word dat hulle 'n grondslag gelê het om op voort te gaan. Een ding is seker. Geen lys sal by almal byval vind nie, en belangstellendes moet gewillig wees om afstand te doen van een of ander gekoesterde voorliefde terwille van die gemeenskaplike saak.

Wanneer die finale konsep deur die Standaards Inrigting aangeneem is, sal dit wenslik wees om in alle kontrakte, spesifikasies en vooraadlyste, 'n spesiale klousule in te lyf te dien effekte dat alleen die goedgekeurde benaminge gebruik word.

Suggesties in hierdie verband moet aan die Voorsitter, Hout Sub-Komitee, Suid-Afrikaanse Standaarde-Inrigting, Posbus 727, Pretoria, geaddreseer word, of aan die Ere-sekretaris van die hout Sub-komittee van die Inrigting, Pad Afdeling, Stadhuis, Johannesburg.

Die konsep-benamingslyste volg hierna.

SOUTH AFRICAN STANDARDS INSTITUTION.

(Incorporating the South African Branch of the British Standards Institution)

SOUTH AFRICAN STANDARD NOMENCLATURE FOR SOUTH AFRICAN GROWN WOODS.

Provisional Draft.

SUID-AFRIKAANSE STANDAARDE-INRIGTING

(Waarby ingelyf is die Suid-Afrikaanse Tak van die British Standards Institution)

LYS VAN STANDAARD BENAMINGE VIR HOUTSOORTE IN SUID-AFRIKA GEKWEEK.

Voorlopige konsep.

1. Definition

This nomenclature relates to the names of indigenous and exotic species of trees grown in South Africa.

1. Definisie

Hierdie lys het betrekking op die name van inheemse en uitheemse houtsoorte in Suid-Afrika gekweek.

2. Object

The names have been selected from those in common use with the idea of linking these with the correct botanical names in such a way as to safeguard against misunderstandings between buyer and seller or among members of the public generally.

2. Doel

Teneinde verwarring tussen koper en verkoper of by die publiek oor die algemeen te voorkom, is hierdie name gekies uit die wat algemeen gebruiklik is, met die doel om hulle terselfdertyd by die juiste botaniese name te laat aansluit.

INDIGENOUS SPECIES.
INHEEMSE SOORTE.

	Botanical names. Botaniese name.	Standard name. Standaard benaming.	Other names (to be discouraged) Ander benamings (af te keur)	Ave. weight* Gemiddelde gewig*
1.	Acacia pallens, Rolfe.	Knoppiesdoring Knoppiesdoring		69
2.	Adansonia digitata, Linn.	Baobab Baobab	Cream of Tartar tree Kremetartboom	20
3.	Adina galpini, Oliv.	Matume Mingerhout	Tvl. or African Teak Matoemie	58
4.	Afzelia quanzensis, Welw.	Chamfuta Chamfuta	Chemnen Pod-mahogany	50
5.	Albizzia gummifera C. A. Smith.	Flatcrown Platkroon		30
6.	Apodytes dimidiata, E. Mey	White Pear Witpeer	um-Dakane	51
7.	Burkea africana, Hook	Wild syringa Wildesering		45
8.	Buxus macowani, Oliv.	Cape Box Buksboom	Buig-my-nie um-Galagala Boxwood	59
9.	Calodendron capense, Thunb.	Wild Chestnut Wildekastaiing	um-Baba	44
10.	Cassine croceum, Kuntze.	Saffraan Saffraan	Cape Cherry	54
11.	Celtis kraussiana, Bernh.	Camdeboo Kamdebo	Witgatboom Wit Stinkhout Kamdebostinkhout	47
12.	Cunonia capensis, Linn.	Red Adler Rooi-els		45
13.	Curtisia faginea, Ait.	Assegai Asgaai		55
14.	Cussonia spicata, Thunb.	Cabbagewood Kiepersol	Sambreelboom Noiensboom Umgezisa	31
15.	Diospyros mespiliformis, Hochst.	Madoma Jakhalsbessie	Matoomba	53
16.	Ekebergia capensis, Sparrm.	Dog Plum Essenhout	Cape Ash um-Gwenyezinja	37
17.	Fagara davyi, Verdoorn.	Knobwood Perdepram	um-Lungumabela Wilde harmonk	50
18.	Faurea macnaughtonii, Phill.	Terblans Terblans		60
19.	Faurea saligna, Harv.	Red Beech Rooiboekenhout	Swartboekenhout	48
20.	Gonioma kamassi, E. Mey.	Kamassi Kamassi	Knysna boxwood	55
21.	Harpephyllum caffrum	Kaffirplum Kafferpruim	Suurpruim	40
22.	Heywoodia lucens, Sim.	Umnebelele Kaapse ebbehout	Cape Ebony	58
23.	Ilex mitis Radkl. (Syn. I. capensis).	Whitewood Without	Waterhout um Duma	39
24.	Kiggelaria africana, L.	Wild Peach Spekhout	Vaderlands- Rooihout	47
25.	Lachnopylis floribunda C. A. Sm.	Wild Elder Vlier		47
26.	Millettia caffra, Meisn.	Umsimbete Oemsimbeet		72

*lb. per c. ft. at 10 per cent. m.c.
*ponde per kub. vt. by 10 persent voggehalte.

	Botanical names. Botaniese name.	Standard name. Standaard benaming.	Other names (to be discouraged) Ander benamings (af te keur)	Ave. weight* Gemiddelde gewig*
27.	Mimusops obovata, Sond.	Red Milkwood Moepel	Rooimelkhout	52
28.	Ochna arborea, Burch.	Cape Plane Rooihout		60
29.	Ocotea bullata, E. Mey.	Stinkwood Stinkhout	Cape laurel	47
30.	Olea laurifolia, Lam.	Ironwood Ysterhout	Black Ironwood	61
31.	Olea verrucosa, Link.	Wild Olive Olienhout		69
32.	Olinia cymosa, Thunb.	Hard Pear Hardepeer	Rooibessie	53
33.	Platylophus trifoliatus, Don.	White Alder Witels		37
34.	Podocarpus falcatus, R. Br ex Mirb.	Ouoteniqua Yellowwood Outeniqua Geelhout	Common Yellowwood Bastard, Kalander Umkoba	33
35.	Podocarpus Henkelii, Stapf.	Griqualand Yellowwood Grikwaland Geelhout	Henkel Yellowwood Um-sonti	32
36.	Podocarpus latifolius, R.Br. ex. Mirb.	Real Yellowwood Regte Geelhout	Upright Yellowwood Opregte Geelhout um-Ceya	35
37.	Ptaeroxylon obliquum, (Thunb. Radlk.)	Sneezewood Nieshout		62
38.	Pterocarpus angolensis, D.C.	Kiaat Kiaat	Bloodwood, Mukwa Sealing Wax tree Lakboom(Kejatenhout	41
39.	Pterocelastrus tricuspidatus, Sond.	Candlewood Kershout		57
40.	Pygeum africanum, Hook.	Bitter Almond Bitter amandel	Red Stinkwood Rooi Stinkhout	58
41.	Rapanea melanophleos, (L) E. Mey.	Cape Beech Boekenhout	Kaapse Boekenhout	50
42.	Rhamnus zeyheri, Sond.	Red Ivory Rooi ivoor	Rooi lemoen	63
43.	Rhus legati, Schonl.	Red Currant Bostaaibos	Kieriehout	51
44.	Sclerocarya caffra, Sond.	Maroela Maroela		37
45.	Scolopia mundtii, Warb.	Red Pear Rooipeer	Klipdoring	52
46.	Spirostachys africanus, Sond.	Tambotie Tambotie	um-Tomboti ulu Bande	63
47.	Strychnos atherstonii, Harv.	Um-hambalala Um-hambalala	Cape Teak	59
48.	Strychnos henningsii, Gilg.	um-Nonono um-Nonono	Hard Pear Hardepeer	69
49.	Trichilia emetica, Vahl.	umKuhlu Rooi-Essenhout	Natal mahogany Thunder tree Xmas bells Mawa	36
50.	Vepris lanceolata, G. Don.	White Ironwood Witysterhout	um-Zani	57
51.	Syzygium gerrardi, Sim.	um-Doni Vaderlandswilg		43
52.	Virgilia capensis, Lam (oroboides).	Keur Keurboom		34
53.	Widdringtonia juniperoides, Endl.	Clanwilliam Cedar Clanwilliam Seder	Sederhout Sederboom	34
54.	Xymalos monospora, Baill.	Lemonwood Lemoenhout	Wild lemon	39

II. EXOTIC SPECIES.
UITHEEMSE SOORTE.

	Botanical Names Botaniese Name	Standard Name Standaard benaming	Weight Gewig
1.	Acacia melanoxylon	Blackwood (Swarthout)	42
2.	Acacia mollissima	Black wattle (Basboom wattel)	47
3.	Acacia decurrens	Green wattle (groen wattel)	
4.	Cryptomeria japonica	Cryptomeria	18
5.	Cupressus lusitanica	Lusitanica cypress (sipres)	29
5a.	Eucalyptus cladocalyx	Sugar gum (Suikergom)	
6.	Eucalyptus diversicolor	Karri	54
7.	Eucalyptus globulus	Blue gum (Bloekom)	50
8.	Eucalyptus maculata	Maculata gum (gom)	49
9.	Eucalyptus microcorys	Microcorys gum (gom)	53
10.	Eucalyptus paniculata	Paniculata gum (gom)	66
11.	Eucalyptus pilularis	Pilularis gum (gom)	50
12.	Eucalyptus rostrata (Camaldulensis)	Rostrata gum (gom)	47
13.	Eucalyptus saligna	Saligna gum (gom)	40
14.	Eucalyptus viminalis	Viminalis gum (gom)	48
15.	Pinus canariensis	Canary pine (den)	47
16.	Pinus caribaea	Caribaea pine (den)	27
17.	Pinus halepensis	Halepensis pine (den)	43
18.	Pinus insignis	Insignis pine (den)	33
19.	Pinus longifolia	Longifolia Pine (den)	3
20.	Pinus patula	Patula pine (den)	26
21.	Pinus pinaster	Pinaster pine (den)	38
22.	Pinus taeda	Taeda pine (den)	29
23.	Pinus teocote	Teocote pine (den)	26
24.	Pinus canescens	Grey poplar (Vaalpopulier)	38
25.	Populus deltoidea	Deltoidia Poplar (populier)	31

CORRESPONDENCE
KORRESPONDENSIE

CULTIVATION OF INDIGENOUS PLANTS

To the EDITOR

Sir,

Are we members of the South African Forestry Association really doing all we should to encourage a greater use of our indigenous plants, i.e. trees, shrubs, and herbaceous species? Some good work has been done.

Forty years ago at Concordia, Knysna, some plantings were made of some of the more important indigenous species such as Yellowwood, Stinkwood, etc. At odd times in the last thirty years small official plantings have been made at various places such as Sneezewood at Hanglip, Transvaal, Karee at Holfontein, O.F.S., Assegai at Gouna, Knysna. An arboretum was planted with various Low Veld tree species at Middelkop, Transvaal, about 1916 and again at De Hoek about 1934. Orange Free State schools and Voortrekker enthusiasts were encouraged to plant indigenous trees in 1938-39.

At a few of our nurseries an occasional enthusiastic forest official has raised a few species, but these have chiefly been confined to trees. A few private persons have planted a few specimens of South African trees and shrubs. A pamphlet describing Common Transvaal Trees was prepared in 1934, but, in the absence of good coloured illustrations, it naturally evoked no enthusiasm. We like to talk about ourselves as "True South Africans" or "Ware Afrikaners," but how many of us are doing anything towards trying to raise South African ornamental plants and trying to get others to do so? Why should our gardens and parks still contain chiefly exotics and almost completely exclude indigenous plants? There is of course Kirstenbosch National Gardens, and there has, I believe, been an attempt made with some indigenous planting in Pretoria.

Quite a considerable amount of knowledge must have been gained already about our ornamental plants, but when will it be collected and disseminated so that our nurseries which sell plants to the public can have flowering specimens visible, and plants available for sale? I would emphasise the great necessity for having good specimens planted in or near the nursery so that visitors can see mature plants. It is not much use merely having small plants in tins or trays, for they convey no true idea of what they will become later, when mature or when flowering.

We need not all, however, wait for the dissemination of knowledge already gained by others. Any of us, when seeing a beautiful flowering plant, can try to get seed or cuttings or even young seedlings. We can raise plants and plant them in a spot set aside as a floretum,

shrubbery, garden, call it what you will. We can try some as hedges, some as individual plants. We can note times of flowering and seeding in natural conditions, and also behaviour in the nursery and afterwards, rate of growth, and period before first flowering under cultivated conditions. Then when we have enough reliable information, we should endeavour not only to spread that information but also to encourage the cultivation of any species found suitable.

If forestry officials do not do something in this matter, I do not know who will, for they are the privileged few who are constantly moving about in the open, while at the same time possessing the facilities in the form of established nurseries in which to experiment. The average professional nurseryman will not worry so long as he can sell his widely known exotics. The botanist often is more interested in plants as specimens for a herbarium. The farmer is too busy with other matters, while the average curator of municipal parks and gardens is usually confined to his town and seldom gets out into veld, forest and mountainside. Who else then is ever likely to do the "spade work" of initiating the wider use of our indigenous plants, unless it be forestry officials and other members of our Association? May I now offer a few suggestions as to species worthy of investigation and trial; those known to the writer as already proved are marked P and those now on trial at Port Elizabeth are marked T.

Low Borders		Ordinary Clipped Hedges	
Buxus Macowanii	T	Rhamnus prinoides	P
Andrachne ovalis	T	Rhus lancea	P
Myrsine africana (on trial at Bloemfontein)		Olea africana	P
		Tecomaria capensis	P
Royena hirsuta (On trial at Bloemfontein)		Plumbago capensis	P
		Chilianthus arboreus	P
Portulacaria afra	P	Rhus Burchellii (On trial at Bloemfontein)	
		Ochna atropurpurea	P
		Royena glabra	P

Flowering Trees and Shrubs

Botanical Name.	Common Name.	Common Height. Ft.	Remarks.
Bauhinia Galpini	Pride of De Kaap		Red flowering scrambler P
Bolusanthus speciosus	Van Wyks Hout or Tree Wistaria	20	Purplish blue pea flowers P
Calodendrum capense	Chestnut	30	Pink and White P
Calpurnia sylvatica	Cape Laburnum	12	Yellow pea flowers T
Crotalaria capensis	Lion's Claw	6	Greenish yellow pea flower
Dombeya rotundifolia	Dikbas	15	White
Ehretia hottentotica	Umhleli	10	Lilac T
Erythrina caffra	Kaffir Boom	20	Scarlet in Spring P
Erythrina Humei	Kaffir Boom Shrub	5	Scarlet in Summer P
Erythrina Zeyheri	Kaffir Shrub	2	Scarlet in Summer P
Erica species	Heath		Many shades
Gardenia Thunbergia	Katjiepering	15	White P
Greyia Sutherlandi	Bakhout	15	Coral red
Greyia Radlkoferi	Bakhout	15	Coral red
Indigofera species (O.F.S.)		5	Pink pea flowers
Kigelia pinnata	Sausage tree	30	Dark red P

Botanical Name.	Common Name.	Common Height. Feet.	Remarks.	
Lonchocarpus Capassa	Mphota	20	Pink to violet	
Millettia Sutherlandii		60	Purple	
Mundulea sericea	Cockbush	8	Red to Purple	
Oncoba spinosa	Tongwaan	15	White	
Pittosporum viridiflorum	Huilbos	25	Golden	P
Pterocarpus rotundifolius	Dopper Kejaat	25	Golden	P
Pterolobium exosum			Scarlet fruited scrambler	
Psoralea pinnata	Bloukeur	10	Purplish pink	
Protea species			Many kinds and shades	
Polygala myrtifolia	Langeer or	10	Purplish pink	P
Polygala oppositifolia	Lang-gele	5	Purplish pink	P
Pavetta lanceolata	Xmas tree	15	White	T
Schotia species	Boerboon	20	Shades of Red	P
Securidaca longipedunculata	Violet tree	20	Pink to Violet	
Sutherlandia frutescens	Kankerbossie	3	Scarlet Pea Flowers	P
Sparmannia africana	Stock Rose	10	White	
Virgilia capensis	Keur	20	Pink	P

There are probably very many other indigenous species, especially shrubs, not included above, which are well worthy of trial under cultivation, but every one of the above is known to the writer as an ornamental plant and many have been tried by him with varying success.

If no other member of the Association will tackle the job, as a first step towards collecting and disseminating some knowledge about them, the writer would be glad to receive from any member, notes on any success achieved in cultivating any ornamental indigenous plants. The writer would then write up notes on some of the species, and offer them for publication from time to time in the Journal. It is suggested that, as far as possible, the notes sent should be in the following form :—

Species. (Botanical and/or Common name).
Natural Habitat.
Usual month of (a) Flowering (b) Seeding.
Locality in which cultivated.
Date (a) Seed sown (b) Germinated (c) Pricked out (d) Planted (e) First flowered.
Present Size.
General Remarks.

One or two rather important hints the writer would like to offer to anyone wishing to try indigenous plants are as follows :—

LOW VELD SPECIES. When planting these at higher elevations or in more southerly latitudes, plant them close to and on the north side of, some shelter, preferably in deep soil, as most are tender to cold and are taprooted.

PRICKING OUT. Prick out a few direct as single plants in deep tins; some species show great response to depth of soil and absolute freedom from competition.

SOWING. Some of the hard-seeded species take a long time to germinate unless the seed is soaked for long enough in hot enough water.

Do not sow too deep, use clean sand to cover the seed and a sack to cover seed tins till germination starts; this latter keeps moisture more uniform and reduces the frequency of watering necessary.

PLANTS. Keep most kinds in Nursery till several feet high, repotting into larger tins if necessary; this saves a lot of disappointment and impatience experienced when small plants of slow species are planted out in the open.

NATURAL HABITAT. Study the natural habitat, and hence do not plant on a dry ridge or bank a species that normally thrives near water, and similarly do not plant in a permanently damp, shady spot a species accustomed to hot, dry conditions.

This may sound elementary, but I have seen a Yellowwood from Knysna planted on a dry hillside in Postmasburg with about 14 in. rainfall, and a Van Wykshout from hot, dry Gravelotte in a shady Vlei near Cape Town.

Yours faithfully,

C. C. STAPLETON.

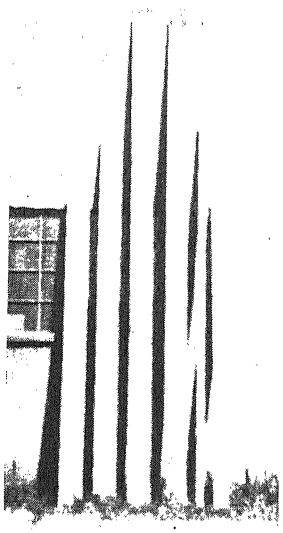
EUCALYPTUS SALIGNA—MINIMISATION OF WASTE.

To the EDITOR.

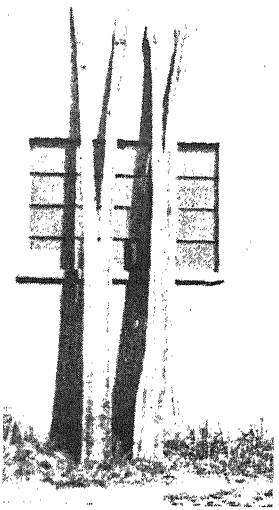
Sir,

My experience in growing Eucalypts dates from 1894 when, as the result of experiments with various species initiated in the Transkei with a view to relieving the strain on the native forests, I found that saligna produced poles in 3 to 4 years pre-eminently suitable for the hut building requirements of a large native population. The trees were planted at an espacement of from 5 ft. x 5ft. to 6 ft. x 6ft., and produced poles with a sound core and free from splitting. At that time there was, of course, no question of producing saw timber, but the experience it afforded in proving how to treat the species silviculturally so as to avoid excessive splitting proved most valuable in later years when growing it for the purpose of producing valuable saw timber. The phenomenally rapid growth of saligna so impresses the amateur grower that his desire is to encourage it still further by increasingly wider planting espacements. By this means he defeats his purpose if he wishes to produce sound timber with a minimum of waste. Trees grown in this manner produce a soft core and heart wood, followed by a semi-hard sap-wood at the age of about 10 to 12 years. It is this difference in texture between the soft inner wood and the hard outer wood which causes the stresses that result in splitting, and which becomes exaggerated by too rapid diameter development during that period. This tendency can be minimised by comparatively close planting and frequent but gradual thinning.

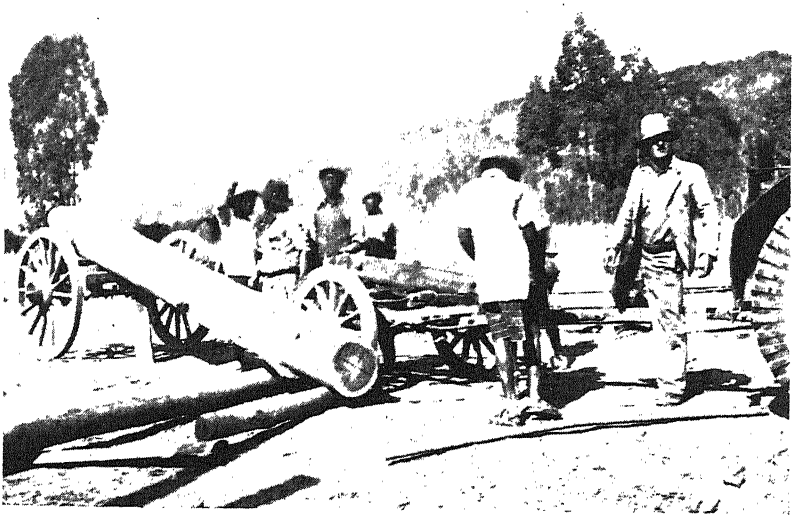
Silvicultural treatment should aim at the production of first class saw timber for manufacturing purposes with a minimum of waste. For this it is necessary to employ every device to retard diameter growth, particularly during the period of principal height growth, 10 to 12 years, instead of the common tendency to accelerate it. I have thoroughly proved the wisdom of this principle by the methods adopted by me at the Frantzina's Rust Plantations in the District of Barberton, eastern Transvaal, as will be seen later.



Saligna timber from 8ft. x 8ft. stand at Frantzina's Rust. The centre planks measure 2in. x 9in. x 18ft. All in perfect condition.



Saligna timber from Frantzina's Rust, showing splitting in outside tree from shelter belt. Sawn on frame saw day after felling.



Saligna timber from Frantzina's Rust. Log from inside tree of 9ft. x 9ft. shelter belt. End cracks are only about 1in. deep and will not extend when log is frame sawn.

SILVICULTURE

Saligna is a summer rainfall tree in its native habitat. It prefers a firm soil of good depth in localities free from severe frost. The rainfall should preferably average 40 in to 50 in. with a maximum of 60 in. Loose, gravelly or shallow soils should be avoided. It has given good results in the George and Knysna districts with an all the year round average of only 30 in., but this has proved insufficient for the best results under wholly summer rainfall conditions. The good results at George and Knysna can be ascribed to there being no appreciable check in growth throughout the year, which tends to produce an even texture in the grain, thus obviating liability to split.

The ideal planting espacement is 8 ft. by 8 ft., whereby a firm core is procured in the heart wood, which is the first essential to obviate excessive splitting. On no account should the espacement exceed 9 ft. by 9 ft. But at this espacement there is a tendency for the plank cut from the centre of the log to develop small cracks all along the middle. This defect is of no account in building timber and other rough uses, but is a decided blemish in high class furniture and for other decorative purposes.

Mathematical thinning to secure regular espacement on the ground should never be attempted. By doing so the best trees may often be sacrificed and weaklings or badly shaped trees left for the final stand. The best trees with average healthy crowns should always be left except when so close together that they tend to crowd each other out in healthy crown development. A pre-arranged policy of a fixed number of trees per acre at any given age should also be avoided. Variations of locality, seasons, and incidence of rainfall, all of which affect rates of growth, are incalculable, and results cannot therefore be predicted with accuracy for any particular time. Judgment and experience are the only safe guides. Perhaps the only thinning which can be predicted with any safety, under normal conditions, is that approximately 30 per cent. of a stand planted 8 ft. by 8 ft. should be removed in about the fourth year. Usually no further thinning will then be needed for two or, sometimes, three years, but after that no definite rate or periodicity can be laid down. During this time the stands must be constantly watched. The important point is to maintain as even a rate of growth as possible consistent with a healthy development of crowns. To secure this condition it may sometimes be necessary to thin twice in a year, at other times once in a year or two may suffice, all depending on the nature of the seasons.

Insufficient thinning can always be rectified by a second operation shortly afterwards. When grown under suitable conditions the crowns of saligna, even if somewhat compressed for lack of space, respond readily when given the necessary space. Depreciation of the ultimate quality of the timber is caused chiefly by abrupt opening up of stands, thereby subjecting individual crowns, particularly after completion of the principal height growth, to undue wind pressure. This results in excessive stresses being set up in the grain of the wood and formation of epicormic branches along the exposed stem. Wide planting and an excessive rate of thinning cause a large percentage of waste in conversion due to splitting and warping, as a result of which only narrow planks and small material is produced instead of the far more valuable broad

planks of good length which command a much higher price in the market. A greater percentage of soft grain, moreover, is produced, resulting in more waste from shrinkage during seasoning, and knots will be larger and more frequent. These defects can all be obviated by close planting and rational thinning.

A private grower in the Duivel's Kloof area, who grows saligna mine poles at an espacement of 9 ft. by 9ft., volunteered the information to me that when he only left one coppice shoot on each stump for the second or subsequent crops there was a tendency to split, whereas this was obviated when two shoots were left. This may not be a serious defect in mine poles, but it provides further testimony to the value of maintaining a close stand to prevent splitting.

Private growers are usually inclined to favour wide planting because of the slightly lower costs of planting and thinning. This is, however, entirely false economy, the extra cost being compensated for many times over by superior results.

In properly prepared ground there should be no need for further cultivation in an espacement of 8 ft. by 8 ft., whereas this is certainly necessary in 10 ft. by 10 ft. or 12 ft. by 12 ft. planting.

Considering the small size of material now used in the mines even the first thinning should yield a certain amount of saleable poles. Between the 6th and 10th years the sale of thinnings should more than pay for the cost, after which a certain amount of saw material will become available in rapidly increasing quantities with each thinning. This increase in quantity will also be accompanied by increased value of timber per unit as the larger dimensions and greater maturity of wood is reached.

Milling

In milling, the chief point to be remembered is that logs must be sawn up within a few days of felling in a modern type of frame saw to minimise the risk of splitting which is present to a certain extent under any circumstances. For this reason it is essential that a properly equipped mill should be within reach of a day's transport from the plantation. Should the mill not be able to cope with the supply of logs sufficiently quickly at certain times, it should be provided with a dam to submerge the logs in water for a time. The dam should not be too deep as the logs will sink and the bottom and sides should be lined with logs to prevent the others sinking into the mud. The logs should not be kept in the water more than a few weeks. If all the sap is washed out by too long an immersion it may affect the strength of the wood owing to weakening of the fibres through excessive swelling and subsequent shrinking during seasoning.

Young saligna can be sawn at the same speed as ordinary imported pine timber, but for wood from 15 years upward, grown under the silvicultural system here recommended, the speed of feeding should be reduced by about 20 per cent.

Ordinary saw blades can be used, but the teeth must be set differently from those used for pine, and slightly different from those for other kinds of hard wood.

Seasoning

Stacking for seasoning at Frantzina's Rust was done in a most careless manner to ascertain the worst effects to be expected. In spite

of this treatment the material showed no ill effects, and came out of the stack after three and a half months seasoning in good condition, apparently fit for use in any climate without any danger of warping, bending or splitting. In no instance was there any sign of surface checking or any other kinds of defect. When the stack was opened up several pieces of wood were thrown on the ground and left exposed for several weeks to extreme changes of temperature from the direct rays of the sun in daytime and cold dew at night. These pieces kept perfect shape with no sign of warping, bending or splitting, which seems to justify the opinion that the wood was well seasoned for all practical purposes. There was no means of gauging the actual moisture content of the seasoned timber, but the following figures of weights before and after seasoning show the actual amount of moisture evaporated during the process :—

Age of tree	Weight per cu. ft. lb.		Moisture evaporated per cent.
	Green	Seasoned	
9 and 10	68.0	32.4	50.4
12	65.8	34.5	47.6
17	62.6	36.6	43.2

The low moisture content of the green wood, which was sawn up the day after felling, can be reasonably attributed to the effects of the silvicultural treatment in retarding diameter growth, and the weights of the seasoned wood seem to indicate that it had been reduced to a 10 per cent. moisture content. (Compare with the minimum weights shown in table I of the article on saligna by M. H. Scott which appeared in your 4th issue, of April, last, page 50 thereof). From these tests it would appear that air seasoning at Frantzina's Rust and similar situations gives satisfactory results without having to resort to the extra expense of kiln seasoning, provided the same silvicultural treatment is adopted, at any rate for thicknesses up to 2 in. Most of the timber required for high-class purposes, such as carpentry, joinery, panelling, etc. ranges from ⅝ in. to 2 in. in thickness. After 4 to 6 months air seasoning at the mill according to the season of the year, any further seasoning required should be done in the stores of the trades concerned who usually have to keep fairly large stocks in hand for future orders. At the present time, possibly due to war conditions, there is a ready demand for building material up to 3 in. by 9 in. which has hardly had any seasoning at all.

WASTE

Unfortunately there was no frame saw available at Frantzina's Rust, and the test had to be made with a circular rack-saw. The carrier of the saw proved to be out of alignment and could not be used, hence the logs had to be guided by hand, which proved a great handicap. But for these disabilities the waste from splitting could have been reduced almost to nil. Logs totalling 280 cu ft. from 9 and 10 year old trees averaging 7½ in., 12 years old of 9 in., and 17 years old of 12 in. in diameter were cut into sizes ranging from ⅝ in. to 2½ in. in thickness and from 3½ in. to 13 in. in width. The comparatively wide planks

obtained from such young trees in spite of the imperfect saw used in breaking down the logs, could not have been secured if splitting had been serious, and speak well for the value of the silvicultural treatment applied. The 10 year old logs were kept in water from 4 to 24 months. All the others were sawn the day after felling. Analysis of the seasoned yield disclosed the following particulars of waste :—

Age	Percentage waste from				
	Sawdust	Shrinkage	Splitting	Slabs, knots, etc.	Total
9	12	10.1	9.6	13.8	45.5
10	12	11.1	6.4	15.2	44.7
12	12	9.9	5.3	13.1	40.3
17	12	10.0	4.6	12.6	39.2

Only two trees were included in the 17 year old class, one of which was taken from the inside of the shelter belt and one from the outside. Unfortunately the particulars for each were not kept separately, otherwise figures for splitting in the inside one would undoubtedly have proved to be almost nil, reducing the total waste to 35 per cent. instead of 39.2 for the 17 year old trees, the only ones approaching comparability in age and size with those reported on in Scott's article.

Scott reports a waste of 45 per cent. in sawing up 100 cu. ft. of logs into $1\frac{1}{8}$ in. green boards at the Forest Products Institute, Pretoria West. He allows 15 per cent. for shrinkage, and a further 13 per cent. during seasoning, presumably due to splitting and warping taking place in that process, and finally arrives at a total waste of 59 per cent. His logs were derived from 15 different localities ranging from the Cape peninsula, all along the East coast up to the Eastern and Northern Transvaal. They ranged from 10 to 42 years in age, the bulk appearing to have come from trees of 25 to 36 years, varying in diameter from 15 in. to 28 in., and averaging 18 in. There is no mention in the article of the conditions and silvicultural treatment under which his trees were grown, or of the condition of the logs in respect of splitting at the time of felling, despatch and arrival at Pretoria. His figures were averaged out for consignments from all sources. The figures quoted by me are in respect of the specific conditions and treatment defined above. The trees concerned were in general younger and smaller than Scott's and their economic conversion was hampered by use of a defective rack-saw as against an up-to-date frame-saw used at the Institute. On the other hand the Pretoria logs had to be transported long distances and probably suffered more from splitting than if sawn up immediately after felling. The disadvantages on both sides probably counter-balanced each other. An up-to-date mill with a modern frame saw was erected at Frantzina's Rust as a result of my tests, and I am informed that the total waste now is only between 30 and 35 per cent.

Quality of Product

The timber from the 9 and 10 year old trees was of good quality for building purposes, such as rafters, flooring, beams, frames, construction work, etc. About 15 per cent. was suitable for flooring

and ceiling boards. The 12 year old trees also yielded good quality timber. About 10 per cent. was suitable for carpentry and joinery. About 30 per cent. was fit for planing into flooring and ceiling boards, and $\frac{7}{8}$ in. by 3 in. flooring blocks could be sawn economically. The balance could be used for building purposes. The 17 year old trees produced timber of an excellent quality suitable for carpentry, joinery, doors and panels for high-class buildings, in fact for all purposes in which teak, oak and mahogany is commonly used. The policy adopted at Frantzina's Rust from the outset was to furnish the Union and South Africa as a whole with a satisfactory substitute for these imported timbers.

The quality of the timber is such that even the slabs can be worked into small pieces suitable for picture frames, electrical fittings and other small decorative articles. In Australia saligna has been extensively used for boat building. The colour of the wood is very attractive. The timber from the 17 year old trees had a fine pink colour when sawn, and rapidly improved and became richer with seasoning. The younger wood was almost pure white when sawn, but gained a nice pink colour during seasoning. The indications are that the longer the wood seasons the more the colour improves. There was never any sign of discolouration.

Value of Product

The present price for saligna sold in the round as mine poles is equivalent to about sixpence a cu. ft., delivered f.o.r. at Eastern Transvaal stations. Saligna building timber finds a ready sale at 4s. 6d. By deducting 35 per cent. for converting round logs into square timber, we arrive at a value of 2s. 11d. in the round. The cost of growing and marketing the material is a matter for each individual to work out for himself.

When it is realised that this class of material is derived from thinning between the ages of 9 and say 15 years, it will be readily understood that the return will far more than pay for the cost of thinnings. Under a system of wide planting say 12 ft. by 12 ft. there is practically no intermediate yield from thinnings, but if some thinning should be required, the material would be practically valueless on account of splitting except for very narrow planks. Present wholesale prices for imported hardwoods average 14s. to 24s. for teak, 12s. to 14s. for oak, and 9s. 6d. to 14s. per cubic foot for mahogany, according to width and length.

The importance, therefore, of adopting a silvicultural system that will produce planks of maximum width and length will be readily understood.

Saligna can be stained to resemble the colour of oak, teak or mahogany, but its own colour, when properly seasoned, is so attractive and distinctive that it will prove a welcome variation from the stereotyped varieties now in use for such a long time.

Yours faithfully,

E. A. CARLSON,
ex Conservator of Forests,
Union of South Africa.

UNITY AMONGST SALIGNA GROWERS.

To the EDITOR.

Sir,

Saligna Growers who read the letter from H. A. Read and the articles by H. M. Scott and R. P. Stephens in the April number of the Journal cannot fail to be inspired and heartened. They will also be well armed with facts to assist them in the approaching fight to establish their industry on a firm and permanent footing. That they will be able to do so without a long and bitter struggle is by no means sure.

It has been shown that there is already a greater area under trees than is required to produce timber for the Mines and more trees are still being planted. It is common knowledge that the Mines have realised the position and are forcing a reduction in the price paid for mining timber. There is therefore the anomalous position of the Mines, on account of the rise in price of gold, being able to pay more but are paying less and the growers, on account of rising costs, are paying out more but are receiving less. Of course those who have planted in marginal areas will be the first to go out, but does the non-marginal grower, who has small transport costs and railage to pay, realise that if he does not help to stem the rot, he will shortly be in the position of the marginal grower who is just making a bare living at present prices.

Because of his fortunate position the non-marginal grower is best able to take the long view and leave many of his trees to grow to maturity. Let him therefore be the first to put on the red tabs of endeavour and go out to meet the enemy before he has to defend his home on his doorstep.

The Mines also can take the long view as they do when it comes to mining low grade ore and building up ore reserves. It is surely better for them to have adequate supplies of timber at reasonable and stable prices than to have the feast and famine of the past. It is not a pretty picture to see the large areas of neglected, snout beetle ravaged plantations on the highveld and it will not help the protagonists of long view efficiency if they force saligna plantations to that stage of neglect when regrowths are not thinned and fire protection is abandoned.

The Government has taken the long view in so far as it has shown us what can be done with Saligna. It has shown us the way, the will to win is up to the growers.

As Agricultural Societies have proved to be foster parents of single product Co-operative Societies, it is trusted, Sir, that you will lend your columns and your aid towards unity amongst Saligna Growers.

It has been shown that we have in Saligna the following products :—

(1) Semihardwood timber suitable for furniture, panelling, flooring and perhaps plywood.

(2) Chemically treated timber which can be used for transmission poles, scaffolding poles, sleepers and if recent experiments of the Chamber of Mines are born out in practice, squared timber of large dimensions which may replace imported timber for which over 10/- a cu. ft. is now being paid.

(3) Wood pulp which with and without the strengthening of Government thinnings of conifers would produce paper for many uses.

(4) Mining timber from thinnings and from less well grown parts of plantations.

Sawn Saligna properly treated has been proved to be a useful timber for many purposes, but it is unknown. Before it can become known and popular it must be abundant but, owing to our short-sighted, short term policy, there is very little saw timber in the country. The vicious circle can only be broken if a determined effort is made. The time to break the circle is now most propitious.

After an era of small timber and close planting, the Mines wanted timber, 5 in. to 7½ in. in diameter for which they paid high prices. As a consequence growers adopted wide spacings sometimes of 10 to 12 feet. The Mines now want small timber again, so what could be better than to give the plantations a drastic thinning by removing all the smaller, crooked and damaged trees to supply the Mines with the small timber they want and leave the large well grown trees to grow to provide saw timber.

No doubt because of the war and the hold up in the expansion of the Mining Industry, production has overtaken consumption sooner than it would otherwise have done, so that the downward trend in prices is already upon us.

Growers are strong enough now to stand the siege if they have the will. If they tighten their belts and do with less they will not be the starved troops putting up a spiritless stand in the years ahead of us.

If 10, 20 or 30 per cent. of our Saligna which is ready for felling is kept off the mine prop market during the next six months, timber merchants will think twice before continuing the price cutting when the Mine Contracts come out next April. If all the growers let 10 per cent. of their trees continue to grow instead of felling every stick and thereby save a 10 per cent. reduction in price, they will receive more money for less work and have something put by for the future.

We have been told that there are 248,600 acres of *Eucalyptus* in the Union and that 75 per cent. of those grown in Natal and Transvaal are Saligna. If we take 70 per cent. there should be 175,000 acres of Saligna planted in the Union.

Taking Stephens's figure of our annual increment for Saligna of 250 cu. ft. per acre we get an annual production of 43,750,000 cu. ft.

Taking Scott's figure of 41 per cent. of merchantable timber we get an annual production of 17,937,500 cu. ft.

Report No. 245 of the Board of Trade and Industries places the total imports of unmanufactured and partially unmanufactured timber for the year 1937 at 33,000,000 cu. ft. valued at £3,310,000 of which 22,000,000 cu. ft. were coniferous softwoods valued at £1,664,000 and other timbers, mostly hardwoods at 11,908,000 cu. ft. valued at £1,696,000.

These comparative figures are mentioned to show that potentially the Saligna Industry is a big one and worthy of all the support which the Government and people of South Africa can give to it.

The following are some suggestions as to what can be done to meet the situation :—

(1) Let every grower restrict felling by leaving to grow to maturity, as many trees as he can afford to leave. The fact that he leaves these trees should be well advertised to his friends and neighbours and to the purchasers of his timber.

(2) Plantations to be felled next year should be thinned this year, preferably under the guidance of a Forest Officer. The thinnings so obtained will help to take the place of the timber left standing under this year's felling programme.

(3) Groups of growers should get together in an eandeavour to form Saligna Associations out of which may be formed Provincial and National Associations such as the Wattle Growers Union in Natal.

(4) Where seven or more growers are in close proximity endeavours should be made to form a Co-operative Society. The writer is Chairman of the first Transport Co-operative Company registered in the Union. The Company, composed of seven Saligna Growers, has been granted a loan of £3,600 by the Land Bank to purchase tractors and trailers. After the members of the Company have shown that they can work together successfully, they hope to form a Selling Company and later undertake collective Saw Milling.

In this District there is a Company owning Saligna Plantations. In April last their saw mill, comprising 1 frame saw, crosscut and edging saws commenced operations on 20 year old trees. The sawn timber has been readily sold, the turnover for August being £650.

Individuals, small companies and Co-operative Companies could, with the financial help of the Industrial Finance Corporation and the Land Bank, erect such breakdown plants near their plantions, transporting their rough lumber to central mills or kiln drying and further processing as recommended by Scott.

(5) Every opportunity must be taken to make representations to such bodies as the Rural Industries Commission and the Board of Trade and Industries, to remove the disabilities under which the industry is suffering. The most serious is that whereby the Railways discourage the establishment of rural saw mills by the high rate on logitudinally sawn timber.

In report No. 245 of the Board of Trade and Industries, in the Timber and Saw Milling Industries, occurs the following "(26) for reasons fully set out in paragraph 51 the Board supports the centralized sawing and preparation of mine timber. For this reason it is unable to support representations for reduction of the railway rate on mine pack mats."

It is evident from the arguments used in paragraph 51 that rural interests had not stated their case very well. Here are two points among many which could have been put up in favour of rural saw milling.

Scott states that Saligna logs should be sawn as soon as possible after felling.

Mat packs could be made from the slabs and crooked pieces and railage and transport would not have to be paid on saw dust, waste and water.

Yours faithfully,

E. T. E. ANDREWS,

P.O. Box 118, Barberton.

A PIONEER *EUCALYPTUS* PLANTER.

To the EDITOR.

Sir,

In writing the historical sketch of forestry in the first number of the Journal, it was a pity that Mr. King did not know of my own father's pioneer efforts in *Eucalyptus* planting on the Willows, as I think his must have been almost the first commercial plantation in the Transvaal. It was, of course, long before my time, and unfortunately I have very few particulars. I believe he started planting well before 1880, as a result of having met Baron von Mueller of the Australian Forestry Department at a dinner in London. My father reported on soils, climate and rainfall as extensively as he could in those days, and the Baron selected seed of trees which he considered should be suitable. A forester, trained in Switzerland, did most of the planting, mostly in single jam tins, so that the cost, naturally, was quite uneconomic, and many of the varieties, being purely experimental, did badly or failed to survive.

It has always seemed unfortunate to me that the Forestry Department has made so little use of this experiment.

Yours faithfully,

FRANK STRUBEN.

Pretoria.

STATE POLICY REGARDING INDIGENOUS TREES.

To the EDITOR.

Sir,

I beg to resign my membership of your Association as I find it primarily concerns exotic trees in which I am not interested.

I cannot understand why the Forestry Authorities in this country take so little interest in the properties and advantages of our own indigenous species—why they do not advocate their use, in afforestation as well as in towns and along the highways of South Africa. Our country is rapidly losing its original character, and with toxic blue grass, wattles, pepper trees, and every known variety of pines and fir introduced, the Union is assuming the character of some queer Lemurian continent.

Yours faithfully,

GORDON LEITH.

[Mr. Leith's reproach has been brought to the notice of the Director of Forestry who has kindly furnished us with the following statement in reply thereto.—*Editor.*]

Mr. Leith is under a misapprehension in saying that "the Forestry Authorities in this country take so little interest in the properties and advantages of our indigenous species." If he will go back into the history of our indigenous forests a sketch of which has been given by Mr. King in several contributions to the Association's Journal he will appreciate what the forest service has accomplished in the reservation and protection of our indigenous forests. He will also appreciate the

long drawn out struggle to prevent the complete ruination of the forests by woodcutters—a struggle which has at last resulted in placing the management of the forests on a much more satisfactory basis. The forest service is now in a position to reduce the annual cut to the capacity of the forests and thus slowly rebuild the forests. The process of rehabilitation necessitates careful investigations into the difficult problem of regeneration with the more valuable timber species. Experiments on a fairly large scale have been inaugurated at Knysna and in other parts of the country. As far as funds will permit a general cleaning up of worked out forests is taking place. The output of stinkwood is now being regulated to ensure that approximately the same amount will be made available each year in perpetuity. The uses to which indigenous timbers can best be put and the correct methods of seasoning are among the functions of the Forests Products Institute which is carrying out investigations in these directions. Arrangements are, moreover, already well advanced for the establishment by the Division of Forestry of a hardwood mill, one of the functions of which will be to place on the market in manufactured form indigenous woods which have hitherto not been saleable in the round. It is thus hoped to open up markets for woods which in the past have been left to clutter up the forests and impede regeneration of more desirable kinds. The use of indigenous species for ornamental planting is advocated wherever they are likely to succeed and annually considerable numbers of such plants are raised and disposed of at cheap rates.

In regard to the use of exotics which is deplored by Mr. Leith it should be borne in mind that, exclusive of scrubs, savannahs and low forest along the coast, the total area under high quality forests is less than 0.2 per cent. of the total area of South Africa. Obviously this small area is quite inadequate to meet the timber requirements of the country and further, with the exception of yellowwoods, the forests do not yield the class of timber required for general construction work. Attempts have from time to time been made to propagate indigenous species for commercial purposes but experience has shown that they cannot successfully be established in open veld. It is however interesting to note that wherever plantations have been established in proximity to indigenous forests a copious regrowth of indigenous species springs up under the exotics when the latter reach a stage which brings about the right degree of light intensity and a suitable degree of moisture in the upper layers of the soil. In many places the plantations now contain a dense understorey of indigenous trees as illustrated by photographs published in the Department's annual report for 1938/39. The plantations have not only fulfilled a much needed want but have been the means of preventing to a large extent the denudation of the country of its indigenous trees. It should be borne in mind that the gold mines on the Rand require enormous quantities of rough timber and natives need large quantities of fuel, hut building material and kraalwood. Had these wants not been fulfilled by the plantations there is no doubt whatever that large tracts would have been denuded of tree growth.

The fact that members of the Forestry Association take an interest in the Division's policy is appreciated and it is hoped this explanatory note will satisfy Mr. Leith that the matters on which he feels concerned are receiving its earnest attention.

REVIEWS—RESENSIES

A STUDY OF THE EFFECT OF SWAY ON TREES. By *M. R. Jacobs.* (Commonwealth Forestry Bureau. Bull. No. 26 Canberra, 1939.)

The following is the author's abstract of this study:—

> "This paper describes experiments designed to determine the effect of sway upon tree growth. Four test plots were set up in different stands of *P. radiata* and one plot in a sapling stand of *E. gigantea*. In these plots comparable series of trees were laid out, one series being stayed to prevent sway, the other acting as a control. The measurement of the increments on all the plots showed that the prevention of sway caused a marked reduction in diameter growth in the lower part of the bole."

Jacobs's field technique and his subsequent statistical reduction of the data obtained are both admirable. His results clearly establish that, for the species studied (and presumably the principle will apply in all species).

(a) the increment of trees in all stands, irrespective of their density, incorporates at least some proportion of "sway stimulus wood."

(b) the increment of "sway stimulus wood" is increased as the severity of thinning (exposure to wind) increases.

(c) "sway stimulus wood" extends up the boles for considerable heights.

These conclusions go far to explain the phenomenal "response" obtained locally in highly suppressed stands of certain conifers when thinned well beyond practical silvicultural limits. They also explain the temporary nature of this "response" without conflicting with the concept that the ultimate volume increment of trees, other things being equal, is directly proportional after thinning to their degree of suppression prior to thinning.

The reviewer is, so far, in complete agreement with Jacobs. The latter, however, goes further. He says that "the effect (of wind) is proportionately greater in an open stand than in a dense stand," that "this abnormal growth is in the nature of a stimulus wood and must be regarded with caution in view of the behaviour of stimulus woods in converted boards" and that "we must beware of obtaining a layer of stimulus wood in our best mill logs." Lane Poole in the foreword to this bulletin states that Jacobs' studies "emphasize the importance of the old teaching of thinning guardedly so as to maintain wind firmness and prevent the production of stimulus wood." Apart from the fact that Jacobs presents neither data nor citation of authority in support of his view that stimulus woods behave undesirably when converted into boards, these generalizations give the definite impression, perhaps unintentionally, that open-grown stands will contain an unduly high proportion of stimulus wood and that, therefore, the resulting timber will be of relatively poor quality.

It is common knowledge that a free-grown (without competition) tree has a large root-spread, a low form factor and a high degree of wind-firmness; that, on the other hand, a suppressed, whippy tree grown in a dense stand has a small root-spread, a high form factor and a low degree of wind-firmness. As stimulus wood is produced with the essential object of increasing stability, we may logically argue that the free-grown tree will be least in need of wood of this character, and that a suppressed stand, if drastically thinned, will rapidly have to adjust itself mechanically to its new environment if it is to survive. The moral to be drawn from this study is, therefore, not that stands should be grown densely or thinned guardedly, but that they should be thinned consistently (whether grown densely or openly is irrelevant to this particular study) so as to maintain homogeneity of wood quality (as far as this is practical) from the beginning of the rotation to the period of harvesting.

I.J.C.

THE VEGETATIVE REPRODUCTION OF FOREST TREES. EXPERIMENT WITH CUTTINGS OF *P. radiata* DON. *By M. R. Jacobs.* (Commonwealth Forestry Bureau, Bulletin 25. Canberra, 1939.)

In this bulletin Jacobs describes the technique which he has developed, following upon the lead given by Field in New Zealand, in the raising of planting stock of *P. radiata* (syn. *P. insignis*) from cuttings. He concludes that under suitable conditions of watering there should be no difficulty in obtaining 80 per cent. success in striking cuttings from parent trees which are old enough to show the form of the butt log. He suggests that a nursery cost of £1 per thousand (labour costs are considerably lower in South Africa) should not be difficult to attain when raising such stock on a commercial scale.

Jacobs deals, inter alia, with the age and type of suitable parent trees, the character of suitable stock for cuttings, the use of hormone extract to stimulate rooting, the collecting of cuttings, the effect of the removal of cuttings on the parent trees, the storage of cuttings, their trimming, setting, watering, weeding, shading, cultivation, lifting and planting. He discusses the season of setting, the striking properties of individual trees and the shoots which develop from cuttings.

The recent modification of local silvicultural policy, both as regards density of planting and subsequent thinning in localities of poor quality, has given special prominence to the desirability of reproducing only such races or strains of parent trees as have shown confirmed superiority. In addition to the importation and trial of seed from specially-selected individual trees of *P. taeda* and *P. caribaea,* and strains of *P. pinaster,* local genetic studies have been initiated on *P. insignis* and *P. pinaster.* The practical significance of this work would, of course, be greatly enhanced were it possible to propagate outstanding parent trees vegetatively. With this object in view elaborate tests of cuttings on numerous *Pinus* species were tried at Groenkloof (Tvl.) and Jessievale (Tvl.). Despite the meticulous application of the technique developed by Jacobs, all results have hitherto been negative. These may, almost certainly, be ascribed to the extreme aridity of the atmosphere during the critical winter,

spring and early summer months which characterise our summer-rainfall area.

A pilot test with cuttings of *P. insignis,* laid down at Tokai in the winter-rainfall area, has, on the other hand, yielded most satisfactory results. Unfortunately the war has drastically curtailed, for the present, any possibility of extending these investigations.

I.J.C.

HANDBOOK OF STRUCTURAL, TIMBER DESIGN. By *Ian Langlands* and *A. J. Thomas.* (Division of Forest Products, Council for Scientific and Industrial Research, Australia. Technical Paper No. 32.)

The bulk of this handbook is devoted to tables of permissible loads for wooden joists and beams from 3in. by 2in. to 16in. by 16in. in section, up to 20 feet long, both centrally and uniformly loaded, and permissible dead and live loads for struts, posts, and columns of the same range of section, up to 40 feet long. The loads reflected are referable to two separate, and defined, grades. It can well be believed as stated in a foreword by the Chief of the Division that these two hundred and more pages of figures are "the results of a huge amount of work." With the preliminary chapters and the subsidiary, but essential, tables, this must have been a colossal undertaking. The reliability of the figures, in view of the aegis under which the book is published, and the reputation of the principal compiler and his collaborators, cannot be doubted. It is not a reviewer's job to test the precision of engineering tables, but ranging through these pages we have encountered no inconsistency such as occasional retrogression when figures should mount from page to page or from column to column. Where such consistency is invariable, and the extremes are accurate, no room for serious error can occur. The main tables are made fool-proof by notes at the head of each regarding modification of values to meet varying conditions of exposure, and to ensure that standard maximum deflections will not be exceeded.

Thirty-six eucalypt species and seven species of other genera, including one exotic, Douglas fir, are dealt with in four groups, each conforming to a considered range of strength values, and an alphabetical list of trade names of the timbers directs the user to the group in which particular timbers fall. Working stresses are given separately for each of the four groups. As the principal strength properties of wood are by no means invariably inter-correlated, it is possible for a single species to conform to more than one group with regard to key strength properties. Only two species out of the 43 listed are affected thus. As the table of species becomes extended with further accumulation of data, a neater device to provide for this in the tabulation might be adopted.

Although the tables are compiled primarily with reference to Australian species, they might be used for any, in any country, by the simple expedient of fitting locally obtained data to conform with the compilers' strength groups. Preliminaries include informative chapters on factors affecting strength of wood and design methods.

Arrangement seems a little casual in places. For instance, an important series of graphs giving the permissible stress for various length-least dimension ratios of wooden columns is ushered in with

no general heading or explanatory note. "P" and "W" are used indiscriminately as symbols for stress. Reference might have been facilitated by repeating titles of tables on each page. The index is not very imaginative. One of the most vital tables in the book, that reflecting strength property ranges for the groups, is not numbered, titled, or even indexed. These are, however, all defects that can be rectified by the user of the book by means of a little judicious manuscript annotation, and the general value of the book is so high that it is well worth his while to effect it.

AUSTRALIAN FORESTRY. Vol. V. No. 1, June 1940. (The Journal of the Institute of Foresters of Australia. 7/6).

This older sister of ours can always be depended on to provide fare of interest to the professional forester. Being the organ of a professional body, its nature is rather different to our Journal, in that its contents are exclusively technical. In the issue before us, T. N. Stoate and J. H. Harding give an insight into the use that has been made of data collected at two Fire Weather Research Stations to arrive at an evaluation of weather conditions in relation to their effect upon the incidence and spread of fires. While it is debatable whether such considerations can ever vie in importance in fire protection with vigilance and application of local experience, this investigation, as a step towards codification of the latter, is commendable and has resulted in a most interesting article. It is particularly interesting to learn that forecasts of the fire hazard to be anticipated for the day in Western Australia are broadcasted each morning from the national broadcasting stations.

D. A. N. Cromer, in "The Frost Resistance of Hoop Pine," concludes from experiments with this species, amongst other things, that small nursery plants are less susceptible to frost damage than larger ones. This has been born out in the Transkei in certain pine stands planted towards the end of the rainy season in which transplants scarcely larger than when they left the nursery survived particularly severe winters, whereas healthy looking stands formed some two months earlier on comparable sites, with the greater part of the rainy season still before them, failed.

In an article on the Forest Botanical Gardens of Charlottenlund, near Copenhagen, A. D. Helms conveys a vivid impression of the intensiveness with which research in forest genetics was being conducted by the Danish government before the German invasion. In discussing Jacobs's experiments in the vegetative reproduction of *Pinus radiata,* the officer in charge of the gardens admitted complete defeat in this respect with all pine species so far dealt with, and the author suggests that the possibility of *Pinus radiata* being a hybrid should not be disregarded.

In a systematic study of lean in the same species, J. M. Fielding finds a distinct correlation between angle of lean and pith displacement. As eccentricity in conifers is almost invariably associated with compression wood formation along the longer radius, consideration of sylvicultural devices for the minimisation of lean assumes importance.

R. Powles describes the progress of research into the most effective way of regenerating certain burnt and cut-over areas of mountain ash (*Eucalyptus regnans*) in Victoria. When it is remembered that members of the ash group of eucalypts scarcely coppice at all, the urgency for this intensive investigation will appear.

J. L. d'Espeissis, in "The Timber Industry in New Guinea," examines the prospects of an industry that has sprung into being almost overnight. Australia supplies only one fifth of her own softwoods requirements, and here, on a neighbouring island, exist stands of the softwood species, hoop pine, with which the Australian market is most familiar, and apparently plenty of ground for their extension. Up to 1937-38, in which year £6,030 worth of logs were exported, the highest figure for any one year was £705 in 1934-35. Of the native gums, *Eucalyptus deglupta* is regarded as one of the finest hardwoods of the Territory, but is not likely to find a market in a country so well provided with excellent hardwoods as Australia.

L. D. Pryor, in a short note, classifies exotic conifers according to their susceptibility to fire damage as observed in certain small stands and arboreta of young trees burnt in 1939. The locality is not named. His four classes are very resistant, resistant, susceptible, and very susceptible. In the first named group, *Pinus canariensis* stands alone. *P. longifolia* apparently was not present on the plots, but South African experience should justify its sharing pride of place with *P. canariensis*.

T. N. Stoate and B. H. Bednall discuss analytically the girth-height relationship of co-dominants in jarrah forests, with a view to devising some convenient modification in the use of height of crop as an indicator of forest types.

I. H. Boas, in his "Forest Products Notes," emphasises the subordination of normal timber investigative work to Defence problems that is a natural outcome of existing circumstances.

J. H. Harding contributes an interesting note on the treatment of seeds of *Acacia pycnantha* and *A. acuminata,* which should recommend itself to the attention of tan-bark wattle growers in South Africa, or their technical advisers; and A. A. Hone closes the list of articles with an anlysis of the results of tending in a 545 acre tract of Victorian ironbark forest over a period of thirteen years.

PUBLICATIONS RECEIVED
UITGAWES ONTVANG

Copies of the following publications have been received with thanks :
Ontvangs van die volgende uitgawes word met dank erken :

ANNUAL REPORTS :
Union of South Africa Division of Forestry, 1938-39.
British Honduras, 1939.
Nyasaland Protectorate, 1939.

EMPIRE FORESTRY JOURNAL, Vol. 19, No. 1, 1940.

FORESTRY, Vol. xiii, No. 2, 1939.
xiv, No. 1, 1940.

NEW ZEALAND JOURNAL OF FORESTRY, Vol. iv, No. 4, 1939.

PHILIPPINE JOURNAL OF FORESTRY, Vol. 2, No. 3, 1939.
No. 4
Vol. 3, No. 1, 1940.

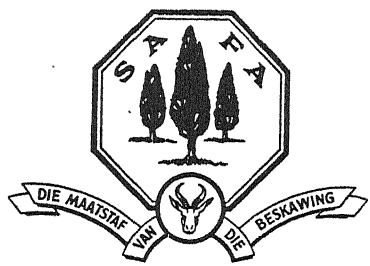
SOIL CONSERVATION, by Hugh Hammond Bennett. London, McGraw-Hill. 1939. 40s.

Die

Tydskrif van die Suid-Afrikaanse Bosbouvereniging

April

UITGEGEE DEUR DIE VERENIGING
April en Oktober



The

Journal of the South African Forestry Association

April

PUBLISHED BY THE ASSOCIATION
April and October

No. 6. 1941
PRETORIA
6/-

SUID-AFRIKAANSE BOSBOUVERENIGING

Beskermheer:

SY EKSELLENSIE DIE GOEWERNEUR-GENERAAL,
DIE HOOGEDELAGBARE SIR PATRICK DUNCAN,
G.C.M.G., K.C.

President:

DIE EDELAGBARE KOLONEL DENEYS REITZ, L.V.

Vise-Presidente:

DIE EDELAGBARE KOLONEL W. R. COLLINS, L.V., D.T.D., D.S.O.

HANS MERENSKY, DR.ING.H.C., D.SC.

H. J. VAN DER BIJL, D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.

P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.

C. E. LEGAT, C.B.E., B.SC.

J. HUNT HOLLEY.

T. M. MACKENZIE.

AMPSDRAERS:

Voorsitter: J. D. KEET, DIP.FOR., M.SC. (ERE.)

Vise-Voorsitter: H. A. READ, F.S.A.A.

Ere-Redakteur: J. M. TURNBULL, DIP.FOR.

Ere-Sekretaris-Tesourier: I. J. CRAIB, M.F., PH.D.

Uitvoerende Komitee:

J. D. KEET, DIP.FOR.,M.SC. (ERE.), (*Voorsitter*)

H. A. READ, F.S.A.A. (*Vise-Voorsitter*)

H. A. LORENTZ, LL.D.

PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.

W. E. WATT, A.F.C., B.A., DIP.FOR.

J. M. TURNBULL, DIP.FOR. (*Ere-Redakteur*)

I. J. CRAIB, M.F., PH.D. (*Ere-Sek.-Tes.*)

SOUTH AFRICAN FORESTRY ASSOCIATION

Patron:

HIS EXCELLENCY THE GOVERNOR-GENERAL,
THE RIGHT HON. SIR PATRICK DUNCAN, G.C.M.G., K.C.

President:

COLONEL THE HONOURABLE DENEYS REITZ, M.P.

Vice-Presidents:

COLONEL THE HONOURABLE W. R. COLLINS, M.P., D.T.D., D.S.O.
HANS MERENSKY, DR.ING.H.C., D.SC.
H. J. VAN DER BIJL, PH.D., D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF,
P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.
C. E. LEGAT, C.B.E., B.SC.
J. HUNT HOLLEY.
T. M. MACKENZIE.

OFFICERS:

Chairman: J. D. KEET, DIP.FOR., M.SC. (HON.)
Vice-Chairman: H. A. READ, F.S.A.A.
Hon. Editor: J. M. TURNBULL, DIP.FOR.
Hon. Secretary-Treasurer: I. J. CRAIB, M.F., PH.D.

Executive Committee:

J. D. KEET, DIP.FOR., M.SC. (HON.), (*Chairman*)
H. A. READ, F.S.A.A. (*Vice-Chairman*)
H. A. LORENTZ, LL.D.
PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.
W. E. WATT, A.F.C., B.A., DIP.FOR.
J. M. TURNBULL, DIP.FOR. (*Editor*)
I. J. CRAIB, M.F., PH.D. (*Sec.-Treas.*)

REDAKSIE-KOMITEE.

J. M. TURNBULL, DIP.FOR. —*Voorsitter.*
I. J. CRAIB, M.F., PH.D.
A. JURRIAANSE, B.SC. (LB.), B.SC. (BSB.)
J. D. KEET, M.A. (ERE.) (*Ex officio.*)
PROFESSOR E. J. NEETHLING, B.A., M.F.
A. J. O'CONNOR, DIP.FOR.
PROFESSOR JOHN PHILLIPS, D.SC., F.R.S.E., F.L.S.

Artikels oor alle aspekte van bosbou sal deur die Redaksie-Komitee in oorweging geneem word, en moet aan die Redakteur, ,,Die Tydskrif van die Suid-Afrikaanse Bosbouvereniging,'' Posbus 727, Pretoria, gerig word. Artikels van meer as 1,000 woorde moet van 'n opsomming van nie meer as vyf persent van die lengte van die artikel self, waarvan kopiereg nie voorbehou is nie, vergesel word. Twaalf herdrukke van elke artikel sal kosteloos aan die skrywer daarvan verskaf word. Mits hulle bestel word voor die einde van die maand voorafgaande die van uitgawe, kan herdrukke bo hierdie hoeveelheid teen die volgende pryse vir eenhede van vier teksblaaie verkry word :—

100	*kopies*	*£0 16 6*
250	,,	*£1 5 6*
500	,,	*£2 0 6*
1,000	,,	*£3 10 6*

Onvolledige eenhede sal teen dieselfde prys as volledige eenhede gereken word. Gedrukte omslae, bestel belyktydig met die herdrukke, sal voorsien word teen 21/6 per 100, en 2/- per elke 50 bo die eerste 100. Illustrasies ekstra.

Kontribusies sal gepubliseer word in die taal waarin hulle ingestuur word. Opsommings mag in enige of beide amptelike tale ingedien word.

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of opinies van skrywers nie.

Lesers word versoek om die Vereniging se adverteerders waar gerieflik, in aanmerking te neem.

EDITORIAL COMMITTEE.

J. M. TURNBULL, DIP.FOR.—*Chairman.*

I. J. CRAIB, M.F. PH.D.

A. JURRIAANSE, B.SC. (AGRIC.), B.SC. (FY.)

J. D. KEET, M.A. (HON.) (*Ex officio.*)

PROFESSOR E. J. NEETHLING, B.A., M.F.

A. J. O'CONNOR, DIP.FOR.

PROFESSOR JOHN PHILLIPS, D.SC., F.R.S.E., F.L.S.

Contributions on any aspects of forestry or allied subjects will be considered by the Editorial Committee, and should be addressed to the Editor, The Journal of the South African Forestry Association, P.O. Box 727, Pretoria. Articles in excess of 1,000 words should be accompanied by uncopyrighted summaries, not exceeding five per cent. of length of originals. Twelve reprints of each article will be furnished to its author, free. Reprints beyond that number may be obtained, if ordered before the end of the month preceding that of issue, at the following rates per unit of four text pages :—

100	*copies*	*£0 16 6*
250	*,,*	*£1 5 6*
500	*,,*	*£2 0 6*
1,000	*,,*	*£3 10 6*

Incomplete units will be charged as for complete units. Printed covers ordered at same time as the text will be provided at 21/6 per 100, and 2/- for every 50 in excess thereof. Illustrations extra by arrangement.

Articles will be published in the language in which they are submitted. Summaries may be submitted in either or both official languages.

The Association does not hold itself responsible for statements or views expressed by authors.

Readers are urged to consider the Association's advertisers as occasion may arise.

INHOUD—CONTENTS

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of menings wat deur skrywers uitgespreek mag word nie. Met uitsondering van skrywers se opsommings, word kopiereg van alle artikels voorbehou.

The Association does not hold itself responsible for statements or views expressed by authors. With the exception of authors' summaries copywright of all articles is reserved.

BLADSY PAGE

VAN DIE REDAKSIE—EDITORIAL NOTES AND COMMENTS 1

THE NEW FOREST ACT.

GROOT BOME.

'N BEROEP OP MEDEWERKERS.

A PLEA TO CONTRIBUTORS.

THE ESTABLISHMENT AND MAINTENANCE OF FRESHWATER FISH IN SOUTH AFRICA, *by D. Hey, D.Sc.* 4

THE EXPLOITATION OF THE INDIGENOUS FORESTS OF SOUTH AFRICA, *by N. L. King, Dip.For.* 26

THE VALUE OF AN IMMATURE PLANTATION, *by A. J. O'Connor, Dip.For.* 49

AN APPROACH TO THE STUDY OF RAINFALL INTERCEPTION BY FOREST CANOPIES, *by C. L. Wicht, B.Sc., B.A., Dr.Ing.* .. 54

SOUTH AFRICAN WATTLE BARK AND WATTLE EXTACT WITH SPECIAL REFERENCE TO THE AMERICAN MARKET, *by I. J. Craib, M.F., Ph.D.* 71

NATIVE NAMES IN USE IN SWAZILAND FOR TREES SHRUBS AND OTHER PLANTS, *by O. B. Miller* 89

KORRESPONDENSIE—CORRESPONDENCE 98

WHAT'S IN A NAME?

RESENSIES—REVIEWS 100

PINE NUTRITION AND FUSED NEEDLE DISEASE AND ITS RELATION TO THE NUTRITION OF PINUS.

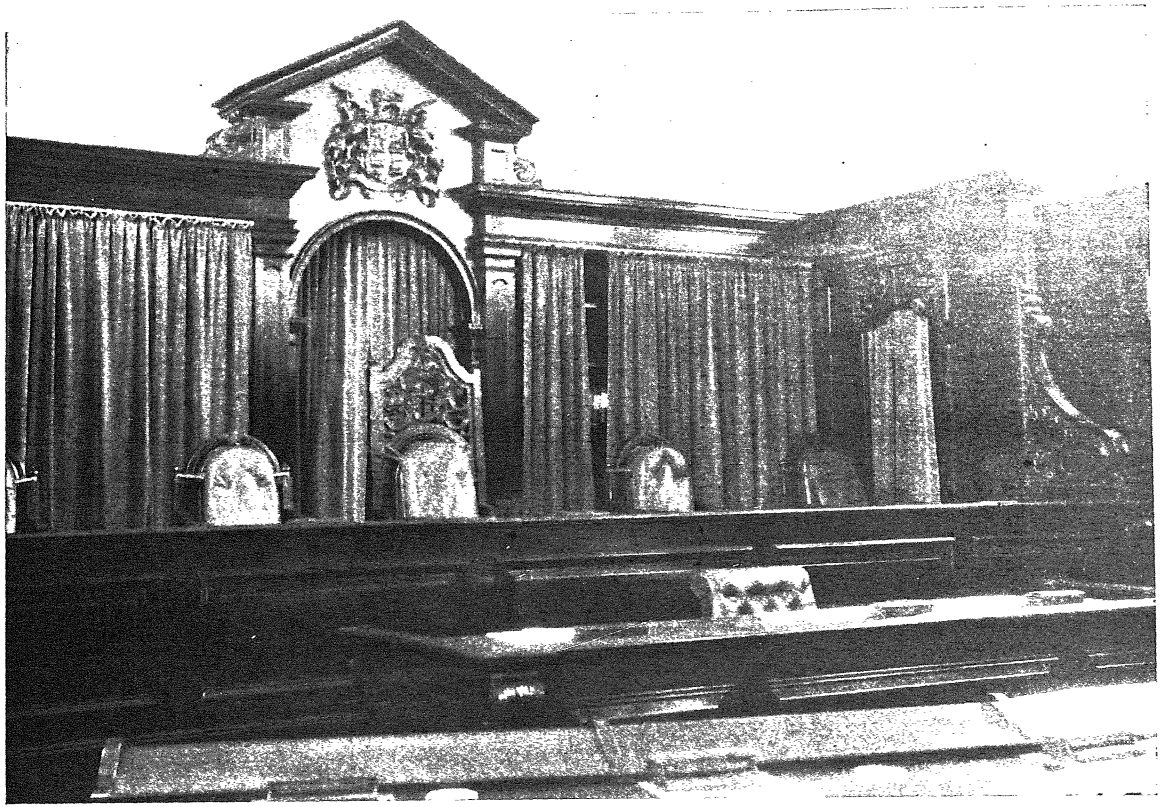
EVIDENCES OF RACIAL INFLUENCES IN A 25 YEAR TEST OF PONDEROSA PINE.

INFLUENCE OF VEGETATION AND WATERSHED TREATMENTS ON RUN-OFF SILTING AND STREAMFLOW.

TRANSVAAL CHAMBER OF MINES. TIMBER RESEARCH LABORATORY. ANNUAL REPORT 1939.

SOIL CONSERVATION.

PUBLICATIONS RECEIVED 108



DIE WAARDIGHEID VAN DIE HOF.
Stinkhout binnewerk, Appélhof, Bloemfontein.

DIE TYDSKRIF VAN DIE
SUID-AFRIKAANSE BOSBOUVERENIGING
No. 6. APRIL, 1941.

THE JOURNAL OF THE
SOUTH AFRICAN FORESTRY ASSOCIATION
No. 6. APRIL, 1941.

VAN DIE REDAKSIE.
EDITORIAL NOTES AND COMMENTS.

THE NEW FOREST ACT.

The Forest and Veld Conservation Act—No. 13 of 1941—which was passed during the last session of Parliament marks an important stage in the history of Forest legislation in South Africa. Legislation, to be effective, like a tree, must be the result of growth. Each successive measure aiming at the conservation of a land's natural resources should be instituted to provide against contingencies that at a preceding stage were not apparent, to block up hitherto unnoticed loopholes through which the spirit of the law might be violated, to facilitate its application and to consolidate regional and interim enactments. The drafters of the present act seem to have succeeded in these respects to an extent that will secure its immunity against drastic revision for many years to come. In the first Forest Act to be passed after Union—No. 16 of 1913—the interests of private owners were inadequately safeguarded. Under its provisions it was necessary for owners who desired that the act as a whole apply to their forests to have those forests declared demarcated forests. This was a lengthy process and not very satisfactory. Under the new act the only land that can be declared demarcated forest is Crown land; but the Governor-General may, on the written request of the owner of any private forest, by proclamation in the Government Gazette, apply to that private forest any provisions of the Act that relate to Crown forests which he may deem necessary for its better preservation. Any person specially appointed by any private forest owner as forest officer shall, moreover, have all the powers conferred on forest officers of the State. It will thus be seen that the protection of private forests is dealt with more simply and adequately in the new Act.

The provisions relating to the lighting of fires in forests or in veld are improved. Under the older enactments it was an offence to set fire to

veld without the consent of the owner of the property concerned; but the owner himself could do very much as he liked. He will in future be controlled by a provision in the new Act making it an offence for any person to leave unattended a fire which he has lit in the open air on any land, or to allow it to spread or cause injury. The new Act also empowers any land owner to clear fire belts on his boundaries and to demand that the adjoining owners assist at their own cost.

The Act invests the Crown with very wide powers in connection with the protection of private land. Under Section 6, the Governor-General may declare that any tree or the whole or any part of a forest or plantation on any land be protected if he deem it expedient in the public interest to do so. Provision is made for the owner of such forest or plantation to claim compensation for any loss he may suffer. It is to be hoped these wide powers will be exercised with discretion.

The far-reaching scope of the Act is evidenced by the provisions made for control of the export and import of timber and of methods of manufacture, seasoning, grading, etc. of wood and other forest products.

GROOT BOME.

Dis verbasend hoe dikwels aanspraak gemaak word dat die grootste boom van sy soort ontdek is. Dit gebeur in 'n menigte gevalle waar die ontdekker wat tevore die boom alleen in 'n ongunstige omgewing geken het, vir die eerste maal met middelmagtige bome van dieselfde soort in 'n gunstige streek kennis maak. In ander gevalle weer neem die boom 'n ontsaglike groote aan as dit deur die vergrootglas van eiendomstrots aanskou word. Om rede van sy wyd verspreide lidmaatskap kan ons Vereniging nuttige werk doen om wat hierdie saak betref presiese gegewens in te samel, en lede asook nie-lede word hiermee uitgenooi om afmetings van totale hoogte en omvang borshoog—d.w.s. 4vt. 0dm. bo die grond—van enige boom wat as abnormaal groot beskou mag word in te stuur. Dit sou ondoenlik wees om al sulke rapporte te publiseer, en dit word derhalwe voorgestel dat, na die insameling van 'n taamlike hoeveelheid data ten opsigte van indiwiduele boomsoorte, die mees treffende afmetings vir inskrywing in die Tydskrif uitgekies sal word. Afmetings moet waar moontlik deur 'n professionele bosbeampte of land- of mynopmeter gemaak of nagesien word, en die naam en beroep van die opmeter in elke geval gemeld word. Alvorens enige rapport gepubliseer word, sal stappe gedoen word om die botaniese identiteit van die betreffende boom te bekragtig. Dit sal egter onnodig wees om kiekies of kruiemonsters in te dien voordat daarvoor gevra word. Inligting oor beide inheemse en uitheemse soorte sal op prys gestel word. Voorlopige rapporte moet sover moontlik die volgende gegewens bevat: boomsoort, lokaliteit, datum van meting, totale hoogte in voete en omvang in duime.

'N BEROEP OP MEDEWERKERS.

Ons vra die leser om verskoning vir die laat verskyning van hierdie en sommige vroeëre uitgawes van die Tydskrif. Indien nie stiptelik, is ons in alle geval konsekwent. Terselfdertyd, is dit wenslik dat die Tydskrif sy verskyning gedurende die bepaalde maande sal maak, en in dié verband kan skrywers vir ons baie hulp verleen. Besieling ontbreek nie, maar, net soos met die Tydskrif, skyn dit te laat aan te klop. Ons is dikwels deur voornemende skrywers gevra wat die laatste datum is waarop artikels vir 'n sekere uitgawe bestem ingehandig kan word. Wel, sonder om te waarborg dat enige artikel in enige gespesifiseerde uitgawe geplaas sal

word, kan dit tenminste gesê word dat artikels wat voor die einde van Februarie- of Augustusmaand ontvang word, gewoonlik die beste kans staan om in die volgende April- of Oktober-uitgawe, respektiewelik, geplaas te word. Beter sou dit egter wees om die artikel neer te skryf sodra dit in die skrywer se verstand ontwerp is, en die manuskrip dadelik in te stuur sodra dit voltooi is. Indien dit dan te laat is vir plasing in die aanstaande uitgawe, kan dit goed op tyd vir die volgende een geredigeer, en miskien geset, word.

A PLEA TO CONTRIBUTORS.

We crave our readers' indulgence for the late appearance of this and previous issues. At any rate, if not prompt, we are consistent. At the same time it is very desirable that the Journal should appear during the advertised month of publication, and it is thought that intending contributors could assist in this to a large extent. Inspiration is adequate, but, unfortunately, like the Journal, seems to knock at the wrong time. We are frequently asked by intending contributors what the latest date for submission of articles for a forthcoming issue is. Now, while the Editorial Committee does not commit itself to the publication of accepted contributions in specified issues, it can be stated that articles intended for the April and October issues should be submitted not later than the end of February and August, respectively. A still better plan to adopt is for authors to write what they have to say as soon as they have got it planned out in their minds, and to submit their manuscripts as soon as they are completed. If by then they are too late for the immediately forthcoming issue, accepted articles can be edited and set up in good time for the next one.

THE ESTABLISHMENT AND MAINTENANCE OF FRESHWATER FISH IN SOUTH AFRICA

By D. HEY

(*Assistant Curator, Jonkershoek Trout Hatchery.*)

Great as are the benefits to be hoped for in public works, those to be derived from the application of a rational water culture to private grounds are probably in the aggregate far greater. The making of a pond on the home farm is good work for the slack season, and once properly constructed, it is permanent and will, with a minimum of attention, yield returns out of all proportion to its cost. It will yield fresh fish for the table. It will yield healthful sports for the boys and girls who should be kept at home. It will yield beauty; the beauty of a mirroring surface, reflecting trees and hills and passing cloud; the beauty of the aquatics planted on the shoreline, the beauty of the water animals, of flashing dragon flies, and gyrating beetles and leaping fishes. It will add to the joy of living.—J. G. Needham.

1. The Importance of Dams and Streams

THE majority of South Africans associate fish with the sea. A few are acquainted with freshwater species, but their interest is centred mainly in the sporting aspect. Freshwater fish is considered by them to be unsuitable for the table owing to its numerous bones and a muddy flavour. Apart from the fact that very few people understand the cooking of freshwater fish—a matter that will be dealt with briefly in a later article —this idea originated when, with the exception of the indigenous species, Carp were the only freshwater fish in the country. Owing to the introduction of edible and sporting fish from America and Europe, it is now possible to place fresh fish on the table in any inland town—fish which is superior to most sea fish in flavour, texture of flesh and food value.

Although in Europe and America fish farming is a very common practice, it is known in South Africa. Here the development of inland waters is in the hands of a few private enthusiasts supported to some extent by the Jonkershoek, Pirie and Howick Hatcheries. It is in the interests of any country to develop its inland fisheries, either for sporting or economic reasons. From a sporting point of view, good fishing is a direct financial asset to a country. New Zealand is renowned for its trout fishing and attracts thousands of tourists annually. Even in South Africa trout fishing is popular, notably in the rivers of East Griqualand and Natal. Considered from an economic point of view, however, the inland fisheries at present represent one of the Union's undeveloped food resources.

A fish pond if properly managed will produce a greater weight of fish per acre at a lower cost, and with less labour, than the weight of beef produced by a comparable agricultural or pastoral field. In France, on poor soil, production averages 164 pounds of fish per acre as compared



FIG. 1.—Ideal bass water.

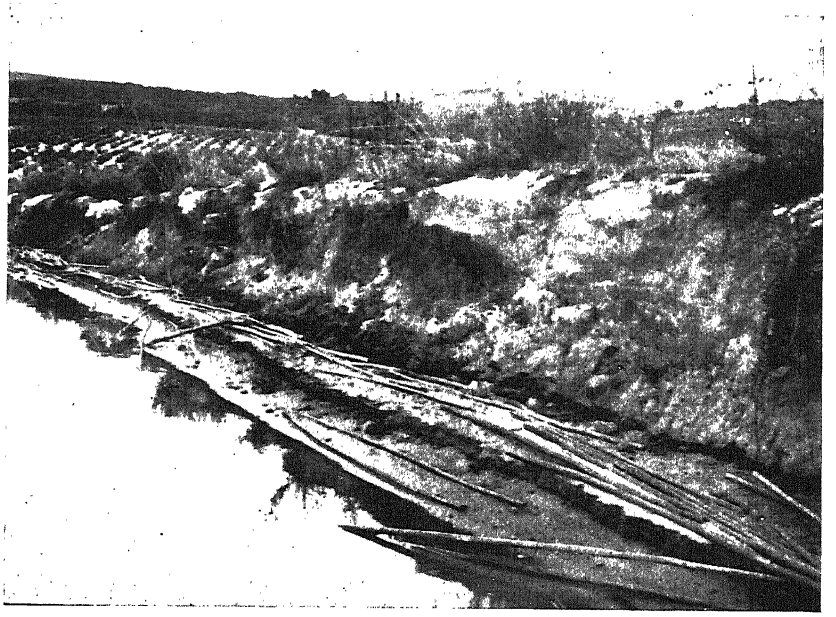


FIG. 2.—Dam wall eroded by wave-wash.

with 149 pounds of beef per acre on the same land when used as pasture (10). In America under controlled conditions production has been as high as 800 pounds of fish per acre (17). In Germany the productivity varies considerably. The annual yield of carp ponds in which there is no feeding or manuring varies from less than 100 pounds per acre on poor soil to 348 pounds on rich soil (1). A good example of the productivity of fertilised water is illustrated in the ponds at the sewage disposal works in Munich. These are supplied by effluent mixed with fresh water and productivity is over 1,000 pounds per acre (13). Good fish ponds in the Philippine islands produce 2,500 pounds of milkfish per acre (6).

The object of this series of articles is to show how the farmer, forestry official or piscatorial society may propagate freshwater fish for commercial, sporting or private purposes. The information given is not always original and much of it has been derived from overseas sources. It has, however, been modified and supplemented as a result of research undertaken in this country. There is still much to be learnt about the behaviour of the various exotic species of fish in this country, but if all those who have introduced fish into their dams or streams will contribute their quota of information to the officers working on the subject, fish culture in South Africa will in time be placed on a firm basis.

The subject is to be divided into three sections. The present article describes the methods of improving dams and streams at present unsuitable for fish, and the maintenance and management of such dams. The second will describe the life histories, habits and methods of stocking the various species of fish suitable for running water, and the third will give similar information as applied to still waters.

Dam Construction

Many dams at present unsuitable for fish culture could, with very little labour, be adapted successfully for that purpose. Although a few hints on dam construction will be given, this information is intended mainly to show how existing dams might be improved. Anyone intending to construct a dam is well advised to obtain expert advice on the subject.

In South Africa all dams are constructed primarily for the conservation of water. If, at the same time, they could be adapted for fish culture, without interfering with their original function, their value would be considerably increased. Although it would be inadvisable to keep fish in small dams where the water is intended for human consumption there is no danger of pollution in large open waters. Fish such as trout, bass, perch and bluegills, actually improve a water supply and have been placed in many large town reservoirs as, for example, at Cape Town, Kingwilliamstown and Grahamstown.

Dams may be of various types such as excavated, ravine or leveéd, but whatever the type, when used for fish culture, it is essential that the walls be water-tight. Apart from the fact that a leak tends to weaken a wall, fry readily escape through any crevices.

Before constructing the wall it is advisable to plan it roughly. This can easily be done with a few rods as shown in Fig. 3. By doing this the dimensions and slope of the wall can be fixed accurately. The points to be remembered are that the base of the wall should be at least twice its height plus the width of the crown; that the width of the crown should be half the height of the wall; and that the slope of

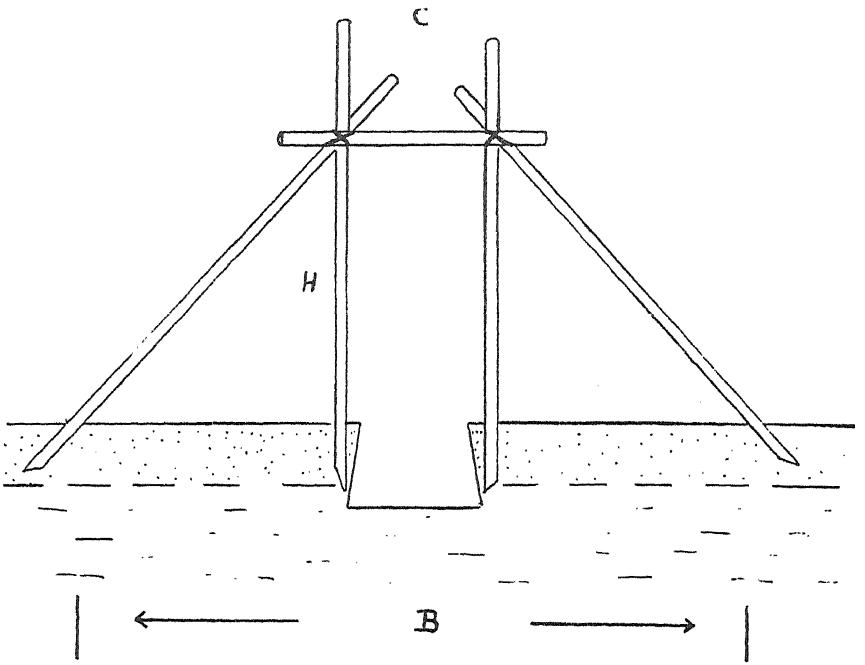


FIG. 3.—Plan of wall. B = base, C = crown and H = height.

the wall should depend upon the material with which it is constructed. For small dams up to six feet deep, where the wall is made of heavy material, a slope of one in one and a half is quite satisfactory. Where the wall material is light, such as sandy loam or loam, a slope of one in three is advisable. In large dams where the wave action is strong a slope of at least one in four on the water-side is necessary.

The base of the wall must rest on an impervious layer as shown in Fig. 4, otherwise seepage may take place. Should there be a leak in the wall, it may be rectified in either of the following ways: 1. Dig a trench approximately two feet wide longitudinally through the middle of the wall onto the impervious layer (see Fig. 4 middle drawing). This trench is then filled with damp clay (sugar dry), each layer being rammed as tightly as possible. It has been found that this forms a better core than is formed by the old method of puddling. In the latter case the core tends to crack when it dries. 2. Sink a trench at the base of the wall on the waterside onto the impervious layer as shown in the bottom drawing of Fig. 4. Ram with clay as described above. Then surface the inner face of the wall with a mixture of clay and sand in the proportion of four to one, six to twelve inches deep. The use of pure clay is not advocated as it cracks when dry. This method has the disadvantage of rendering that surface of the dam unproductive of the fauna and flora which are so essential for successful fish-culture.

Grass should be planted on both sides of the wall. This will tend to bind it and thus check all forms of erosion. In addition marginal equatic plants are useful for preventing erosion of the inner face of the wall caused by wave-wash. In large dams where the soil is sandy, wave-wash can prove a serious menace to the wall as shown in Fig. 2.

It may be counteracted to a certain extent by allowing a slope of at least one in four on the water side, but in serious cases paving with rock or brick is the only solution.

The crest of the wall should be about two feet above the water level. This can be controlled by a spillway, which should be paved to check erosion and screened to prevent the loss of fish. It should be large enough to carry off all flood water. The use of screens in fish culture is essential. They are as important to the fish culturist as fences are

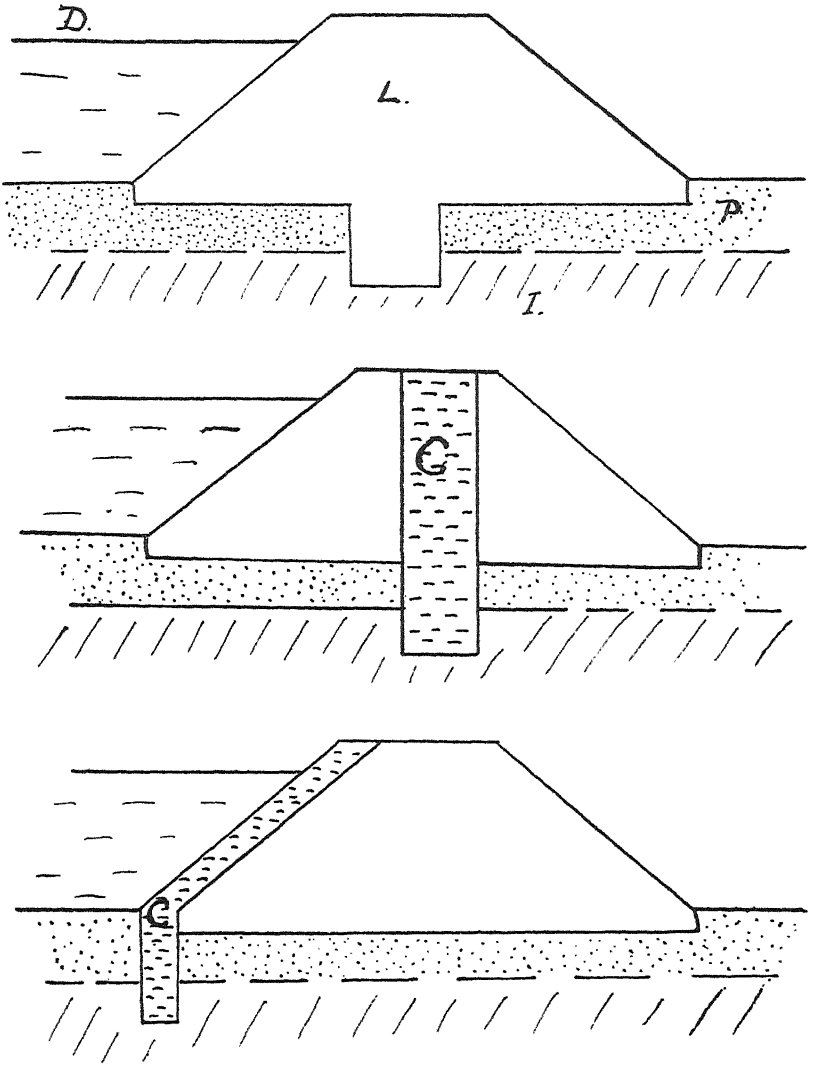


FIG. 4.—Sections of three types of dam wall. Normal design is shown in the top drawing in which D = water level, I = impervious layer, L = wall, and P = porous layer. In the two lower drawings a clay core or layer is indicated by C.

to the stock farmer. For general purposes the horizontal screen is by far the most satisfactory. This consists of a wooden frame covered with fine-mesh wire gauze (10 to the inch), as shown in Fig. 5, which fits into grooves in the sides of the outlet furrow. It should be as large as

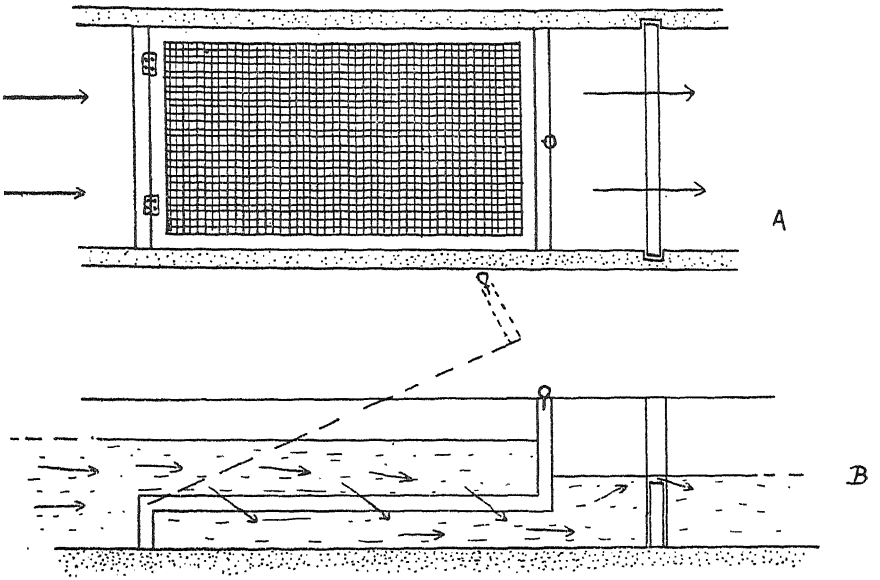


FIG. 5.—Jaffe's horizontal screen. A is plan. B is side elevation showing how screen may be lifted for cleaning.

possible to prevent frequent clogging. Although much cheaper, set screens are less efficient than the self cleaning sorts, especially in waters where little care can be given to periodic cleaning. The most efficient self cleaning screen is the revolving wire cylinder screen built on a strong axle and fitted with greased roller bearings.

Where seepage occurs in the floor of a dam, it may be surfaced with a mixture of clay and sand as described above. As this will render the dam very unproductive, an additional layer of loam six inches deep should be applied. The more fertile the soil the greater will be the productivity of the dam. It is an excellent practice when filling newly constructed dams, whatever the nature of the soil, to follow the advancing water line with a harrow, driving the team knee deep into the water. The constant roiling and puddling of the ground in this manner is very effective in cementing open cracks and crevices.

It is of the utmost importance that all dams should be adapted so that it is possible to drain them completely. The crop of fish can then be gathered and the soil fertilised. All depressions in the floor should be filled in or, if the dam is large, should be made to drain into the main drainage channel. A "kettle," that is, a depression two to three feet below the floor of the dam from which the outlet pipe leads, is a very useful aid in draining a pond. When the dam is emptied all the fish will collect here and may easily be caught with hand nets.

Every dam should be provided with a screened outlet, by means of which the water level can be controlled. The simplest type of outlet

consists of a pipe, draining from the bottom of the kettle and provided with an adequate valve. A more elaborate type of outlet is shown in Fig. 6. This consists of a wooden or concrete tower situated in the deepest part of the dam, from the base of which the outlet pipe leads through the wall. The tower is box-shaped, the open side facing the

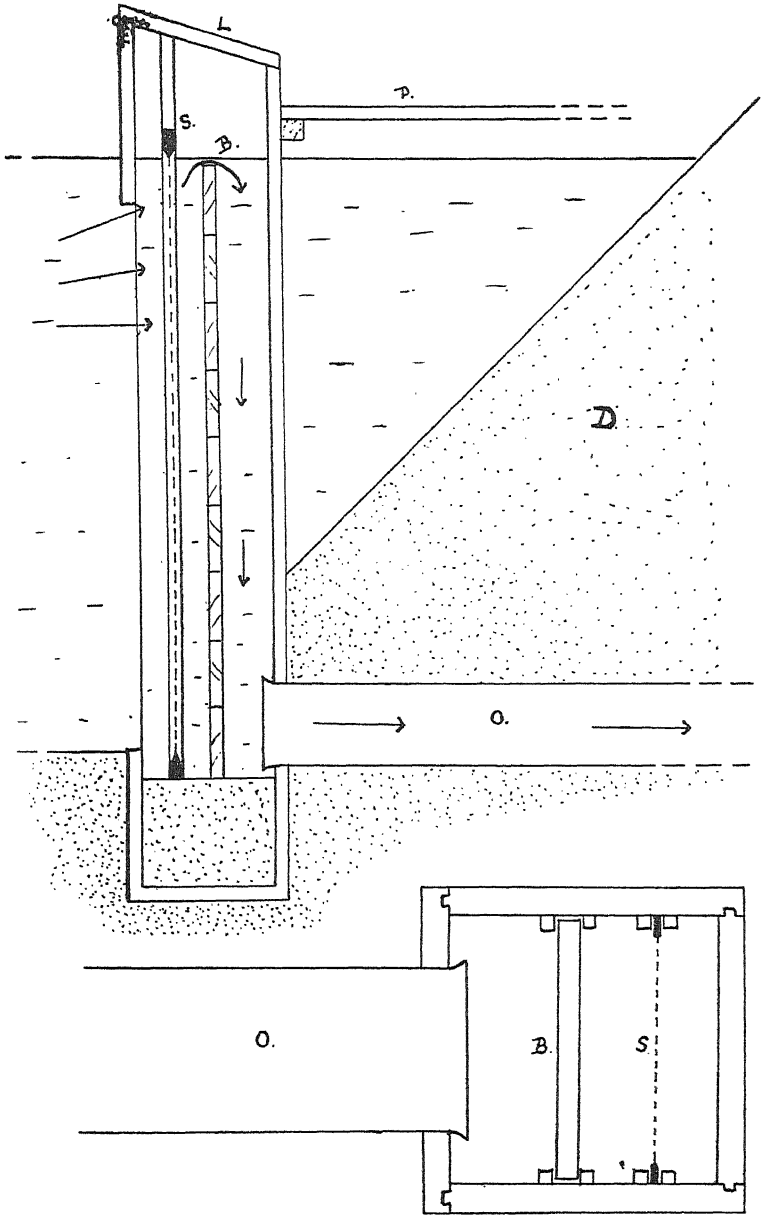


FIG. 6.—Wooden or concrete outlet in cross-section and plan. B = sections of board, D = wall, L = hinged lid of tower, O = outlet pipe, P = platform and S = screen.

dam. This side is provided with two grooves, the outer for a screen and the inner for sections of board. By removing or replacing these sections of board, the water level in the dam can be regulated. The tower should extend at least 24 inches below the floor of the dam and if possible should be embedded in concrete. It may be supported still further by wooden stays. The advantages of this type of outlet are that the water level is automatically controlled irrespective of the amount of water entering the dam, there is no danger of blocking the outlet pipe, and the fish cannot escape.

For successful fish culture 40 to 50 per cent. of the total area of the dam should be shallow. Viosca (17) in America advocates 50 to 75 per cent., but in South Africa, where conditions are warmer this would result in excessive heating of the water. The greatest production of aquatic life takes place in water up to four feet in depth. In this area all the natural food is produced. There is a rapid decrease in both plant and animal life below the six foot contour line since very little sunlight penetrates to this depth. Consequently, the greater the extent of the shoreline in proportion to the area, the greater will be the weight of fish that can be raised naturally in that dam. In large dams the shoreline can be increased considerably by constructing islands in the shallower portions. These are excellent breeding grounds for forage fish. In smaller dams, shallow bays can be excavated with a dam scoop. In fact, all dams used for the propagation of fish should be enlarged to their maximum extent.

Where fish are fed artificially as in trout culture, deeper ponds are far more satisfactory, firstly because trout require cooler water and secondly, because there is no need to breed such large quantities of natural food.

Fish have failed to establish themselves in many waters owing to the lack of spawning facilities. Under such conditions spawning beds may easily be provided. Largemouth bass and bluegills will spawn among the roots of aquatic vegetation, or on the hard ground, in water one to three feet deep. Smallmouth bass, although essentially river fish, will spawn in dams if patches of gravel are provided. Perch spawn among the branches of aquatic vegetation. Where these are not present, branches of trees should be placed round the edge of the dam in water one to four feet deep. In dams which are used for irrigation, care should be taken not to expose the nests, which, as indicated above, are usually in fairly shallow water. Perch spawn in the early spring and bass commence spawning as soon after winter as the water temperature rises above 65°F., which usually occurs from October to December, depending upon the locality. Bluegill sunfish extend their breeding activities throughout the summer months.

Many dams are not as productive as they might be owing to the large number of fry lost by cannibalism. Aquatic vegetation in the shallow areas forms the most effective cover. Where this is not present temporary cover may be provided by placing branches of trees at intervals round the edge of the dam.

The Maintenance of Dams

The longer soil remains under water the less productive it becomes because the atmosphere is no longer able to act upon it. Consequently

the productivity drops each successive year. This may be prevented, however, by fertilisation, which increases the production of natural food. The residual population in a given water area is more or less constant. This population can be increased only in proportion to the amount of organic or inorganic fertiliser which it is possible to add without polluting the water.

The food of freshwater fishes covers a very wide range of organic products, but the group as a whole is predaceous. A few species such as tench, goldfish and tilapia are mainly herbivorous and live on algae and other soft plant foods. Carp live mainly on the organic matter obtained by draining the bottom ooze. They take in and then eject mouthfuls of this mud from which they extract the nutriment. In this way they soon discolour the water if present in large numbers. The young of all fishes feed on microscopic animal and vegetable forms known collectively as plankton.

The production of fish foods is by no means a simple matter but depends upon a complex series of interrelated chemical, physical and biological factors. In order to maintain the proper balance of these factors it is necessary to have some knowledge of the subject. Just as cattle and sheep are dependant upon forage crops so fish are dependant on aquatic plants for their livelihood. But as shown above, very few fish are vegetarians and consequently it is necessary to find intermediary links between the plants and the game fish. This can be done by the proper control of food chains.

The decomposition of organic matter constitutes the first stage in the formation of a food chain. Such decomposition is brought about by bacteria, which feed on organic matter breaking it up into simple substances. These bacteria are ever present in the water, commingling at certain times and places with other bacteria washed in from the surface of the soil. Some of the bacteria from the latter source are injurious to human health, but fortunately they only survive in open water for a short time. The natural water bacteria are mainly beneficial, being of importance in the formation of food chains. Bacteria, like other animals and plants, consume oxygen and give off carbon dioxide. They differ from plants, however, in having no chlorophyl and consequently they are unable to obtain carbon from the air. This they obtain by breaking down carbonaceous organic products such as sugar, starch and cellulose. Many of them produce active ferments which assist in the dissolution of the dead bodies of animals and plants. Certain bacteria begin the work of altering these complex organic substances by attacking the proteins. These are broken down into ammonia and ammoniacal compounds. The nutrifying bacteria change the ammonia compounds into nitrates which can be assimilated by plants. By this means stores of nitrogen within the living bodies of plants and animals are again released for further use. If these simple substances were not returned to circulation all life would eventually cease. Decomposition is therefore a very essential process. The nitrates which are set free in the water form the food of green algae which in turn are devoured by infusoria. The name infusoria is popular, and includes the majority of Protozoa and even the Rotifers. The majority are unicellular, but some consist of colonies of scarcely differentiated cells. Those which are of value as food for newly hatched fish are generally just too small to be detected by the naked eye. All except the very largest will pass through ordinary

butter muslin, and nets should be made of silk bolting cloth. Infusoria and algae form the chief food of crustaceans. In this way the minute plant and animal life of the water is turned into food for the higher animals, as crustacea are the chief food of all young fishes. The crustacea include a host of minute forms such as the water fleas and their allies, known collectively as the Entomostraca, and a number of large forms such as shrimps, prawns and crabs collectively known as the Malacostraca. A few of the latter, such as crabs live in part on land, but all the groups are predominantly aquatic.

Entomostraca and infusoria are found in most natural waters and a fertilised pond will produce large numbers of them. Underground waters, however, are usually devoid of such life, and where dams are supplied by borehole water it may be necessary to secure a stock of these organisms from elsewhere. Almost any pool or vlei contains them and they may be caught with a net of butter muslin or silk, and transferred to the dam. They should be planted immediately after fertilising and about a month before stocking with fish.

The three important groups of Entomostraca are Branchiopods, Ostracods and Copepods. The Branchiopods, or gill footed crustaceans have some portion of the thoracic feet expanded and lamelliform, being thus adapted for respiration. They are extremely diverse in form as for example the shrimp and the waterflea. The Ostracods are minute forms averaging perhaps a millimetre in length, having the head, body and appendages all enclosed in a bivalve shell, eg. *Cypris*. The Copepods are the perennial Entomostraca of open water. They have a pear shaped body with a forked tail, a single median eye and a pair of large swimming antennae, e.g. *Cyclops*. The Entomostraca are scavengers feeding upon the living and dead cells of tiny algae and infusoria as well as the dead tissues of larger plants and animals. Thus they are great water-purifying factors converting decomposable material and bacteria into a form available as fish food.

Aquatic insects also form a fairly important food of game fish. Here, however, the immature stages are aquatic, the adults being usually terrestrial or aerial.

The food chain described above may be represented shortly as follows:—

Organic matter—bacteria—infusoria—small crustacea or insect larvae —game fish. Smaller chains may also exist—fertiliser—aquatic plants —tadpoles—bass; or, organic matter—bacteria—algae—tilapia—bass. Therefore in order that there be an adequate supply of natural food for the fish it is necessary to supply only the first stage of the food chain and the rest will follow automatically.

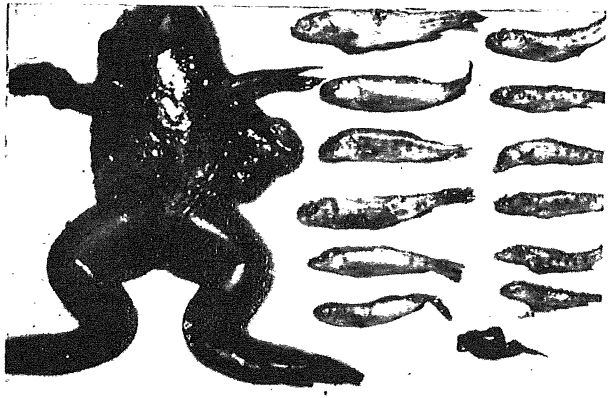
It is essential to empty dams which are used for fish culture every two or three years and to allow them to remain dry for a time. A dam after being drained and refertilised produces the same results as a new dam. After the dam has been drained all silt and sludge should be removed, excessive vegetation destroyed, and fish enemies (see Fig. 7) such as otters, water turtles, legevaans, clawed toads, water snakes and large cannibal fish, killed. Although bird predators, such as snake birds, Cape cormorants and kingfishers (4), do a considerable amount of damage at an institution where fish are kept under intensive conditions, this is not the case in open waters, provided that adequate shelter is available.



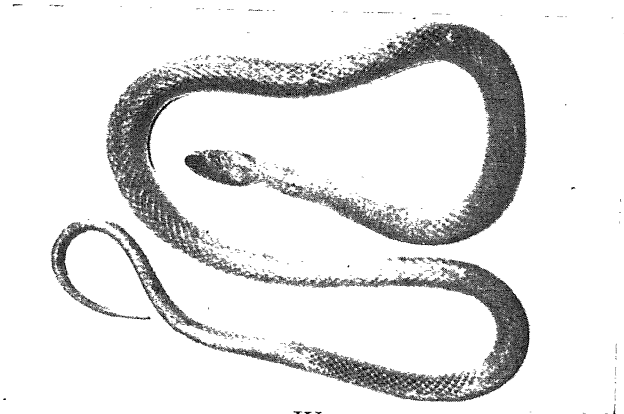
I.



II.



III.



IV.

FIG. 7.—Predators of freshwater fish. I. Giant Kingfisher (*Megaceryle maxima*). II. Malachite Kingfisher (*Corythornis cristata*). III. Clawed Toad (*Xenopus laevis*) showing small trout removed from gut. IV. Brown Water Snake.

Therefore before destroying them, landowners should determine how much damage they are doing, as compared with their aesthetic, educational and scientific value. The kingfishers in particular, although the most beautiful of South African birds, are being ruthlessly exterminated.

As soon as the dam is dry enough a layer of about six inches of soil should be removed. The removal of this layer is very important as it is here that biological absorption takes place. The dam should then be fertilised.

Fertilisation.

The best fertiliser is sheep, cattle or horse manure, the quantity to be applied varying between 500 and 1,000 pounds per acre, depending upon the fertility of the soil (17). The fertiliser should be spread evenly over the floor and walls of the dam and as much as possible ploughed into the soil. Where manure is unobtainable practically any decomposable animal or vegetable matter such as hay, soya bean meal or cotton seed meal may be substituted. If it is not practicable to apply the fertiliser before filling the dam, or if the dam is too large to be emptied, it may be placed in the water round the edge. In this case it is advisable to apply the fertiliser in smaller quantities to prevent pollution.

Lucerne hay is a valuable fertiliser as well as a good source of supply of infusoria and the eggs of small crustaceans. A bale to the acre will produce a good stock of these organisms and is a valuable addition to the fertiliser. Where lucerne is not obtainable any other kind of hay or silage may be substituted.

Some soils and waters are deficient in lime and phosphates. Where this is found to be the case the use of mineral fertilisers is advisable. Water-soluble super-phosphate of lime, 150 pounds per acre, is the cheapest and most effective. Two additional applications of 100 pounds each at intervals of a month should be made.

Pond fish are essentially still-water fish and therefore there is no need to have a stream of water passing through the dam as in the case for trout culture. The amount of water entering the dam should be just sufficient to maintain a constant level. Many dams are not nearly as productive of natural food as they might be, because they have too copious a water supply. Valuable fertilising elements are leached out of the soil and more organic matter is lost at the outlet than enters at the intake. For this reason it is a waste of labour to fertilise either irrigation dams which are constantly being emptied and refilled, or dams used for intensive trout culture in which a strong stream of water is needed. Here natural food should be grown in a separate dam as will be shown in the section on forage fish. In the case of trout culture, however, it is still necessary to drain periodically and to disinfect the dam. The best disinfectant is quicklime, which changes to calcium carbonate in about two weeks, thus having the additional advantage of making the soil alkaline. The use of lime is very important in trout culture where organic fertilisers play a much smaller part.

Aquatic Plants.

Although algae are the lowest form of plant life, they are very important as they constitute the chief food of many aquatic animals. They display a great diversity of structure, existing as single cells, simple

filaments, flat rafts or hollow spheres. The simpler algae are observable chiefly as a result of their mass effects. When present in vast numbers upon the surface of still water they compose the so-called "water bloom." Matted masses of slender green filaments compose the growths that float on the surface in summer as "pond-scums."

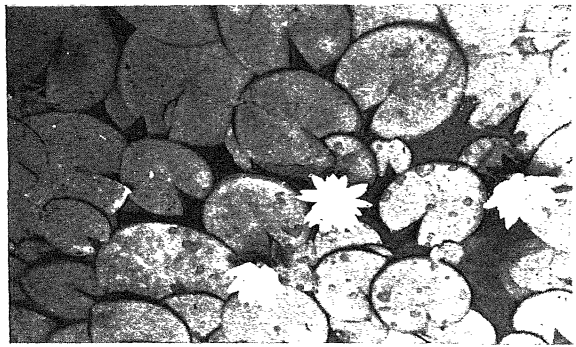
Apart from the algae, which are ever-present, higher vegetation of some kind will make its appearance in a dam sooner or later. Since this will most probably consist of undesirable species, desirable species should be planted as soon as possible. In striking contrast to the algae, these aquatic plants are rooted and are thus confined to shallow water and the vicinity of the shore. They are essential for the high productivity of a dam.

Wherever the average water temperature at the surface is apt to exceed 75°F., it is advisable to introduce plants in order to provide the necessary shade. For this purpose the water lilies are the most effective although they have no additional value. The water lily family (*Nymphaea*) includes the more conspicuous of the broad leaved aquatics (see Fig. 8). They have large root stocks and grow in the rich bottom mud. The leaves are large and shield shaped, either floating on the surface or lifted somewhat above it. They are long-lived perennials and should therefore be kept well under control, as they soon cover the entire surface thus restricting the supply of oxygen and sunlight.

The water hyacinth (*Eichornia crassipes*) is also a shade-producing plant but is not to be recommended in any water used for fish culture as it spreads extremely rapidly. The petioles are large and bladder shaped, causing the plant to float in the water. Propagation is by means of runners on the surface of the water. It is indigenous to America but has been introduced into South Africa.

Certain aquatic plants provide both shelter and food for the microscopic animals upon which the game-fish feed, as well as seclusion for the nests and cover for the fish themselves. A proper assortment of plants will prevent excessive cannibalism by providing cover for the smaller fish. Submerged plants produce oxygen, which, besides supporting the respiratory processes of aquatic animal life, prevent pollution of the water by oxidising the products of decomposition. Aquatic plants greatly increase the surface on which various kinds of food organisms live, thus assuring an increased food supply. In decay the plants add fertilising elements to the water and so increase the food material of the plankton.

Shoreline plants are also of value since they protect the walls from erosion caused by wave wash. This erosion is very common in dams built of sandy material as indicated in the section on dam construction. Uncontrolled wave action roils the water, spreading a smothering layer of silt over the eggs thus retarding their development. Furthermore it is important to reduce the turbidity of the water if a dense fish population is to be raised. Swamp loving trees should be planted along the shoreline and upon islands if present (see Fig. 1). All species of water irises are desirable shoreline plants providing both beauty and shade as well as checking the growth of undesirable plants (see Fig. 8). The rhizomes form a surface mat which binds the soil just below the waterline thus preventing wave wash. Water cress (*Nasturtium officinale*) besides being a useful shoreline plant also harbours a great amount of natural food. Needham (12) has found production as high as 1,229 pounds per acre.



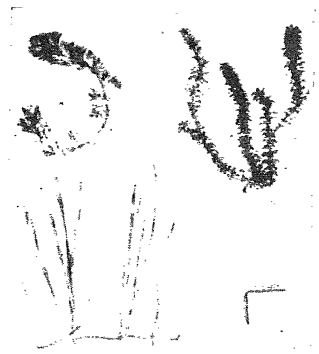
I.



II.



III.



IV.

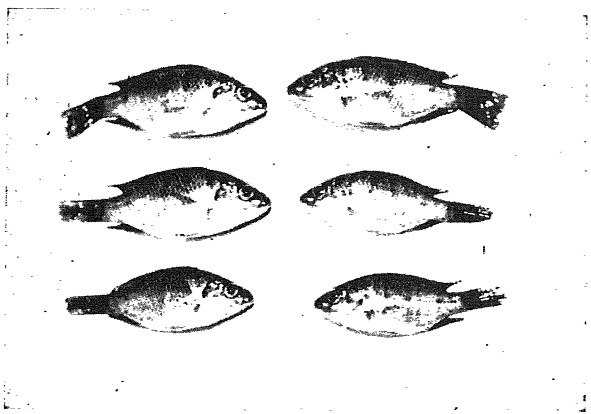
FIG. 8.—Aquatic plants. I. White Water Lily. II. Water Iris. III. Arrowhead. IV. Upper left, Fanwort (*Cabomba*); upper right, Water Pest (*Elodea densa*); bottom, Wild Celery (*Vallisneria spiralis*).



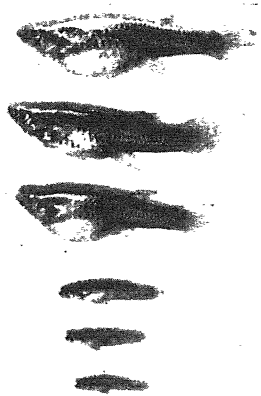
I.



II.



III.



IV.

FIG. 9.—Forage fish. I. Tench. II. Bluegill sunfish. III. Tilapia. IV. Top-minnows (above, females; below, males).

The plant is marginal, the stems being spreading and creeping. The leaves are alternate, smooth and of a deep green colour. The flowers are small and white. It is indigenous to the British Isles.

Of the plants with emergent leaves the arrowheads (*Sagittaria*) are by far the best (see Fig. 8). Besides binding the soil near the shore, the underwater leaves provide food for various organisms. It takes its name from the arrow shaped summer leaves which stand above the water. The underwater leaves are green and strap shaped. The flowers are small and white with yellow centres. Reproduction is by means of runners, although seeds are also produced. There are European and American forms.

Of the totally submerged plants, the wild celery (syn. Italian water weed, eel grass, channel grass—*Vallisneria spiralis*) is perhaps the most desirable (see Fig. 8). It has pale green grass-like leaves. It is an excellent oxygenator and propagates by means of runners. It is indigenous to Europe. The Fanwort (*Cobomba*) is another totally submerged aquatic which is an excellent oxygenator (see Fig. 8). Its finely-cut fanlike leaves are readily eaten by herbivorous fishes. It is indigenous to America. *Elodea* (syn. *Anacharis*) popularly known as Ditchmoss, water pest and water thyme is an aquatic which should be kept well under control (see Fig. 8). It is an excellent oxygenator and harbour for aquatic life but is an extremely fast grower. Consequently it soon chokes any dam if not properly controlled. *Elodea densa* is perhaps a better form than *E. canadensis* for the latter has fine rhizomes which permeate the bottom mud thus making it very difficult to eradicate.

Only one quarter of the area of any dam should be under vegetation. Heavy growths of aquatic plants may actually decrease the food supply for fishes since such plants appropriate oxygen and sunlight, the organic food materials which would otherwise be used by the microscopic plant plankton in starting off the food chain leading to the game fishes. All excess vegetation should therefore be removed periodically. In shallow water this can be done by hand but in deeper water a weed-cutter should be used. Steel cables are very effective in uprooting vegetation and transporting it ashore. One end is attached to a tree or post on the shore and the cable is then laid in a semi-circle, the loose end being drawn in by oxen or a tractor. Strands of barbed wire are very satisfactory for clearing small patches of weed. Vegetation may be rigidly controlled by using certain chemicals but this method is very dangerous. Surber (16) recommends sodium arsenite and gives definite instructions for its use.

Forage.

The secret of successful pondfish culture is an adequate food supply. The greater the food supply, the larger will be the yield per acre. This is the reason why fish do so well in virgin waters, which usually contain copious supplies of aquatic insects, tadpoles and small fish. In the Somerset East district largemouth bass fry have been known to attain a weight of 2½ pounds in one year. In January, 1935, these fry were planted by Mr. S. A. Hey, then Inland Fisheries Advisory Officer to the Union Government, in a dam of about two acres on the farm Glen-Avon owned by Brown Bros. This dam contained large numbers of platannas (*Xenopus laevis*), carp and minnows. In November when these fish spawned they varied between 1½ and 2½ pounds in weight.

Unfortunately the natural food supply soon becomes depleted and has to be supplemented if the quality of the crop is to be maintained. Provided that ponds are fertilised, there will always be an adequate supply of the smaller food organisms, but the productivity may be increased still further by the introduction of the giant water flea (*Daphnia magna*) and forage fish.

Water fleas belonging to the family *Cladocera* are the most common of the Bronchiopods. They are small transparent forms with the body enclosed in a bivalve shell. The heart, blood, muscles and vibrating gill feet can be seen under the microscope. The swimming antennae are of great size. The food of water fleas is mainly the lesser green algae and diatoms. Their importance from a fish-cultural point of view is due to their very rapid rate of reproduction. Throughout the greater part of the summer, broods of eggs successively appear in the brood chamber at intervals of only a few days. The young develop rapidly and are themselves soon reproducing. Needham (11) has estimated that the possible progeny from a single female *Daphne pulex* might reach the astounding figure of 13,000,000,000 in sixty days. Water fleas produce so-called winter eggs which must be chilled before they will hatch. Supplies of small native *daphnia* can be obtained by netting ponds and vleis, but the large American form can only be obtained from Jonkershoek. The winter eggs, which are sent by post must be placed in water and frozen for a few days so as to induce hatching. They can be cultured on a large scale in ponds varying in size from 6 to 40 feet in length and about two feet in depth. These are fertilised with manure, leaves, chopped hay, lucerne or other organic matter. A small quantity of lime or bone meal should be added to prevent the water from becoming acid. Viosca (17) advocates 5 lbs. of fertiliser to every 100 cubic feet of water, to vary one way or the other as experience dictates. Langlois advocates 6 quarts of sheep manure and 1 quart of superphosphates to every 100 cubic feet. The *daphnia* eggs should be introduced about a week after fertilisation and the culture may be kept going all summer by frequent additions of fertiliser.

Although excellent forage for small fry it takes large numbers of *daphnia* to satisfy bigger fish. Consequently it is of advantage to provide forage of a larger size. For this purpose one or more of the various species of so-called "forage-fish" can be used. Ideal forage fish should grow rapidly and have an extended spawning season, thus ensuring an adequate supply of forage of different sizes. They should, moreover, breed easily and prolifically under controlled conditions, and should not compete with the small game fish for the food supply.

There are two groups of forage fish—carnivorous species such as gambusia top-minnows and bluegill sunfish, and vegetarians such as tench and tilapia. Unfortunately the carnivores are competitors for the food which should be utilised by the game fish. The vegetarians however form a very useful link in the food chain converting vegetable matter into available fish food. Herbivorous fish may therefore be used to furnish a principal crop of animal forage. For this purpose carp are of little value as they grow too fast and soon become too large to be eaten by the game fish. Furthermore, they eat the eggs of other fish.

Individual species will now be described from the viewpoint of their value as forage fish. Their sporting and economic values will be considered in a later article.

Tench (*Tinca vulgaris*) are excellent forage fish (see Fig. 9). They are almost exclusively vegetarians and therefore do not compete with the game fish for the food supply. They are extremely prolific. The adults attain a weight of four or five pounds and are consequently too large to be eaten by any of the predaceous species. Thus the parent stock cannot be destroyed.

Tilapia are indigenous to Africa and are widely distributed throughout the continent. Some of the species in tropical Africa attain a weight of three or four pounds and are used by the natives for food. They are mouth breeders, the eggs and young being carried in the mouth of the female. One species, *Tilapia mosambica* (see Fig. 9), is being successfully cultured at the Jonkershoek Hatchery as forage for game fish. They are exclusively vegetable feeders living chiefly on algae. They will also feed on the alga *Spirogyra* (Frogs blanket) which is a pest of the worst type in ponds used for fish culture. Consequently they have proved a great asset, converting otherwise useless vegetable matter into fish food. They are very prolific and can be cultured intensively.

Bluegill sunfish (*Helioperca macrochira*, syn. *Lepomis macrochira*) are extremely prolific and therefore useful forage for the larger game species (see Fig. 9). Their breeding habits will be discussed later. Unfortunately they are competitors for the food supply.

Gambusia top-minnows (*Gambusia affinis*) are small fish, the females being about three inches in length, the males seldom exceeding an inch (see Fig. 9). Consequently there is always the danger of the entire stock being destroyed. They are very prolific, the young being born alive. When present in large numbers they are very useful forage.

A constant supply of natural food would be assured if, besides planting forage fish together with game fish, an additional supply could be grown in a separate dam. Raising animals and their food together is a very wasteful practice. Any small dam between a half and one acre in size would serve the purpose. It should be fertilised and planted with vegetation as described. The forage fish can be netted out and placed in the large dam as required. In America the production of forage minnows varies between fifty thousand and two hundred thousand per acre.

Lake Improvement

Lakes are those natural waters which are too large to be controlled. They can, however, be made to produce large quantities of freshwater fish by creating and maintaining conditions favourable for their growth. As very little work of this nature has been undertaken in South Africa, the information in this section has been derived from the various sources cited; in particular the work of Hubbs and Eschmeyer (8). Anyone desiring more detailed information on the subject will find this book a sound investment.

The three basic principles of lake improvement are—ensuring an adequate natural food supply, providing spawning facilities for the adult fish and providing cover for the fry and forage. The absence of any one of these factors may cause a lake to be unproductive. In many lakes the limiting factor may easily be recognised by anyone with a good knowledge of the basic fish requirements; whereas in others the lack of fish may be due to more obscure factors requiring scientific investigation.

Natural food supply.

The normal rate of fish growth is proportional to the amount of food present in the water. Therefore the natural food supply should be increased wherever possible. This may be done in various ways. Lakes of the oligotrophic type are relatively unproductive because the soil of which they are constructed is poor. These may be fertilised with manure and fertiliser as already described. In such cases the fertiliser must be scattered in the shallow areas in small quantities at frequent intervals.

Many natural lakes are surrounded by vleis which are inaccessible to the fish owing to the presence of mud banks or dense vegetation. As these areas breed great quantities of natural food they should be made accessible to the fry by cutting channels and clearing away part of the vegetation. Lakes should be kept well stocked with forage fish. Species should be chosen whose adults are too large to be eaten by the game fishes, thus assuring ample breeding stocks. The merits of the individual species of forage fish have already been described.

Spawning conditions.

The spawning requirements of the various species of game fishes have also been described. In lakes, as elsewhere, adequate spawning grounds should be provided because if sufficient room is not available for all spawning adults, the same beds will be used repeatedly, thus destroying previously laid spawn. Gravel for the nests of smallmouth bass should be placed in water about 4 feet deep and should be spread out to cover an area of about 2 ft. 6 ins. in diameter. On soft muddy bottoms which will not support the gravel, it should be placed in spawning boxes or on platforms of wood or brush. Although largemouth bass will spawn on gravel or hard bottom, conditions may be improved by planting strongly rooted aquatic vegetation in the shallower areas. At Jonkershoek the bass often spawn in water less than one foot in depth. Trout will only reproduce in those lakes fed by permanent streams suitable for spawning. If unsatisfactory, conditions may be improved in these streams by removing sand and silt from gravel beds or by providing such beds where none are present. If spawning bed improvement is unpracticable in lakes where the natural reproduction is inadequate, the maintenance of the species will depend on annual restocking. For example in the Steenbras reservoir, it has been shown (5) that the reason why the trout have failed to reproduce is most probably the lethal action of the acid water on the milt.

Improving Shelter.

Where spawning conditions and food supply are adequate large numbers of fry will be produced, but unless these are provided with sufficient cover, large losses will result from cannibalism. Weed beds are the chief form of natural cover and as such they are very effective. If aquatic vegetation fails to grow, or until such time as it can be planted, shelters made of logs and brushwood should be provided. These may be circular, hollow, square or irregular in shape as shown in Fig. 10. A framework of the required shape is first made of logs which are sufficiently strong to hold the structure together until it becomes waterlogged. Brush is then piled across the frame so that the bushy ends extend outwards

from the main timbers. To prevent the structure from becoming too compact, brush is also laid parallel to the main timbers. When sufficient brush has been placed on the frame, poles are laid on the top and firmly fastened with galvanised wire to the lower framework. The shelter is then placed in position in the water and firmly anchored. Any timber may be used, for when totally submerged it will last an indefinite time. Piles of old wood, stumps of trees, rocks, also provide excellent shelter.

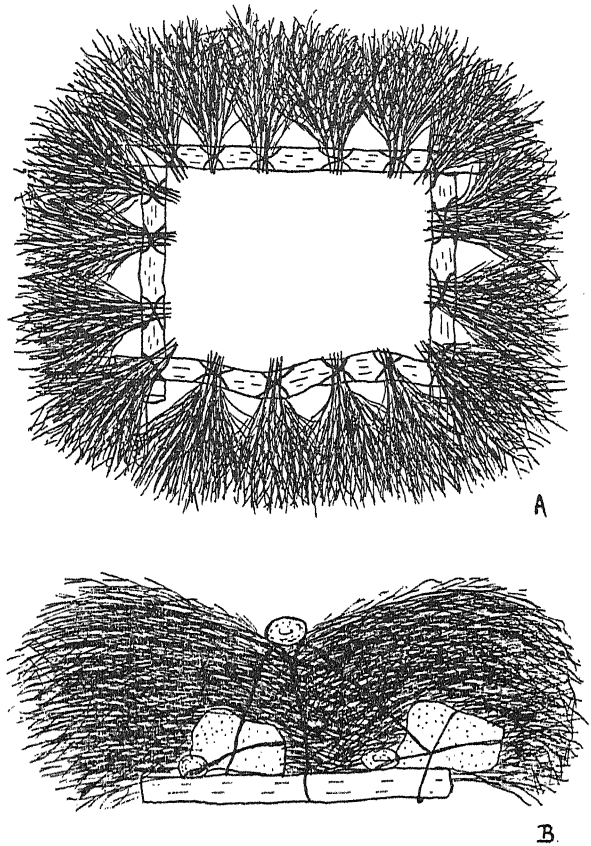


FIG. 10.—Brush shelters [after Hubbs (8)].
A. Top view of hollow square shelter.
B. Side view of ladder shelter.

POND-FIELD ROTATION

The rotation of fish culture with field crops is a method of land use found in many parts of Europe. It yields amazing results as the field crops provide the conditions for the production of fish food and the fish in turn fertilise the soil for the grain crops. As fish culture requires less labour than agriculture, it is especially advantageous during times of scarcity of labour.

This type of land use might be applicable in South Africa, especially in the Western Province with its winter rainfall. Furthermore, owing

to the high water temperature and consequent rapid growth of the fish, it should be possible to rotate every six months, instead of every two years as is the practice in Europe. If adult fish were planted in October, they would probably spawn early in November. Provided that the dam had been well fertilised and stocked with forage fish, the fry should be about one pound in weight by May (fish of about one pound are by far the best for table purposes). The dam could then be emptied, allowed to dry and planted with a grain crop. This could be reaped in September and the dam again filled to receive the fish. This rotation should be very convenient in the Western Province where dams are not needed in winter for the conservation of water.

The Improvement of Streams

The purpose of stream improvement is to create and maintain better living conditions for fish. This has long been a recognised practice in Great Britain and Germany. In Germany, however, stream improvement (Wildbachverbauung) has been carried out to conserve water supplies and control soil erosion. In America trout stream improvement is of much younger date and until undertaken by the State of Michigan in 1927, was executed mainly on club and private waters. This was the first venture in trout-stream improvement on a large scale. It has justified itself by proving that trout quickly respond to and take advantage of the bettered conditions, and in this way long stretches of troutless water have been made to yield good catches.

Before stream improvement can be effected it is necessary to have some idea of the most essential requirements of trout. Trout require pure cold water unpolluted by sewage, winery or factory effluents. The temperature varies with local conditions but the optimum may be regarded as lying between 65° and 70°F. The lethal temperature for trout is about 83°F.(3). There should be adequate clean gravel spawning beds, plenty of shelter and sufficient food. It should be remembered however, that any of these factors, when developed to excess, is detrimental and then becomes a limiting factor. For example the water may be too cold or too pure.

The basic idea behind trout stream improvement is to determine which of these factors is limiting the abundance of trout and then to proceed to improve or overcome the natural deficiencies. A trout stream may be improved by:—

1. providing additional shelter for the fish.
2. preventing extreme seasonal changes in the volume and temperature of the water.
3. improving spawning conditions.
4. improving food supply.

Small streams usually consist of long shallow stretches with very few pools. Besides being subject to great fluctuations in flow, such streams are unsuitable for fish. Suitable streams usually have about 50 per cent. of the area made up of pools and 50 per cent. of riffles. Deep pools interspersed with frequent riffles makes ideal conditions for trout, the pools providing the shelter for the fish and riffles providing the food.

In South Africa there are many small perennial streams which could support a fish population if properly developed. The water should,

however, first be analysed to find out whether it is suitable for fish before undertaking any improvements. No amount of shade or other means of reducing temperature will make a warm stream cold enough for trout.

Streams can be improved by the construction of weirs and deflectors. These provide shelter for the fish, prevent extreme changes in volume of the water and also improve the food supply. How this is done may best be explained by analogy. Confine a flock of sheep to a small pasturage and they exist in a half starved condition. Double the pasture and they thrive. In mountain streams aquatic insects in various stages of their life cycle form the chief food of trout. Increase the surface area covered by water by building small dams and you increase the food supply. In streams with very low banks, which are not shaded, weirs are not advocated as they spread the impounded water and expose it to undue warming. In this case deflectors should be used. Small dams are particularly desirable in streams subject to great fluctuations in flow. In such streams, a large part of the stream bed is simply a waste of dry gavel for a considerable portion of the year. Inundate it, and it becomes the breeding ground for aquatic insects. Small dams also provide holding basins for the trout over periods of decreased flow.

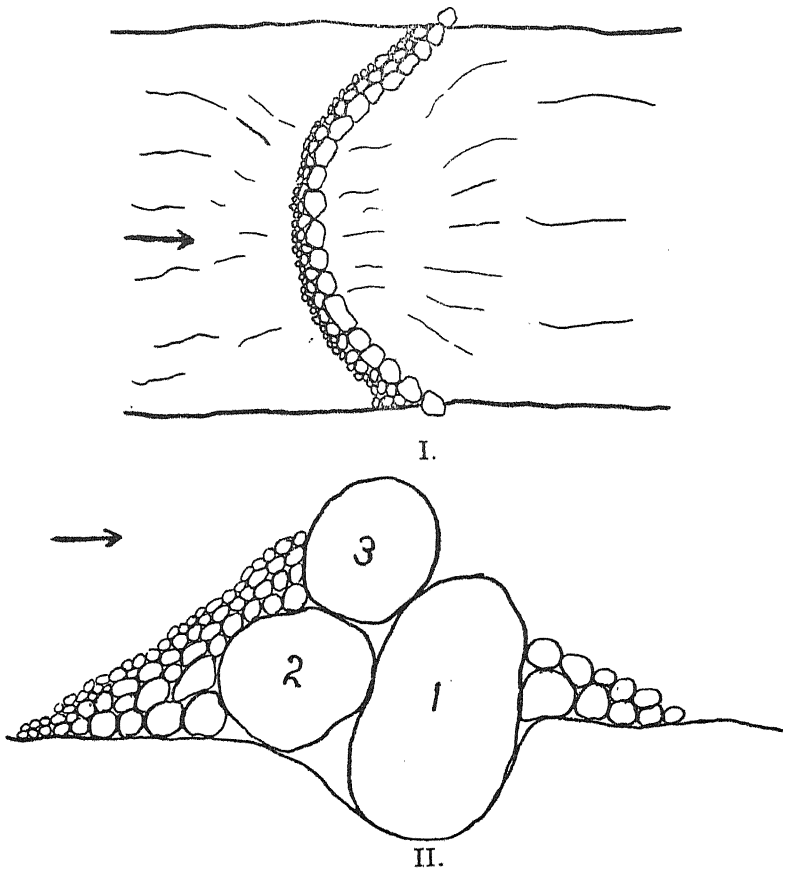


FIG. 11.—Boulder dam. I. Plan. II. Cross-section.

Weirs.

Boulder weirs are the cheapest and most effective and can be built with materials from the stream. Briefly, the procedure is to excavate a trench in the bed of the stream by removing all loose material until a fairly solid foundation is reached. The trench should be crescent shaped, the convex surface facing upstream. A row of large boulders should then be placed in the trench and the spaces between them filled in with stones. A second row of smaller boulders is then placed on the upstream side of the first, after which a third row is placed on top of the first two as shown in Fig. 11. Finally small stones and gravel are shovelled against the weir on the upstream side. This type of construction utilises the force of the current in wedging the boulders together. To prevent erosion of the stream bank, the two wings of the weir should be higher than the centre, thus forcing the flow over the centre of the dam. This will also cause the formation of good pools both below and above the weir. In planning stream improvement it should always be remembered that it is better to construct three 1-foot dams than one 3-foot dam.

In streams with mud or rock bottoms, where boulders and stones are not obtainable, weirs may be constructed of logs laid lengthwise across the stream. These may be of various designs as illustrated in Fig. 12. In all cases however, the logs should be embedded in the banks of the stream to prevent the current from cutting round the ends. The logs are held in position by stakes driven into the bed of the stream. The weir is made watertight by shovelling debris against it. Provided good shelter is also available, a depth of 2 to 6 feet is sufficient for these small dams, depending upon the streamflow. Practically any small mountain stream can be improved by this means. For example, the Jonkershoek Hatchery, where twelve species of fish are cultured, is supplied by a stream of .3 cusecs or 6,726 gallons per hour.

Apart from providing sanctuary for fish, small weirs of the type described above conserve water. This is very necessary in many headwaters where streams are rapidly losing their permanence owing to the denudation of their catchment areas.

Deflectors.

Deflectors utilise the current in improving the stream. By blocking part of the stream, the free flow is concentrated and accelerated. When the velocity of a stream is doubled in this manner, the eroding power is increased four times and the carrying capacity sixty-four times. The effectiveness of this type of stream improvement is determined by the angle at which the deflector is placed. A 30°-60° angle with the current ensures a powerful action (7). When accelerated by a deflector the current is able to move a considerable amount of material. Where a stream is confined to a narrow channel by a deflector a long deep pool is scoured out, the sand and silt thus removed being piled up to form a bar. The exposed gravel is washed clean and is of use for spawning purposes. Furthermore this gravel is more productive of trout food than sand. As shown in Fig. 13 deflectors may be constructed of logs or boulders as described for weirs. In warm streams they are far more effective than the latter for by increasing the depth and decreasing the surface they tend to keep the water cool.

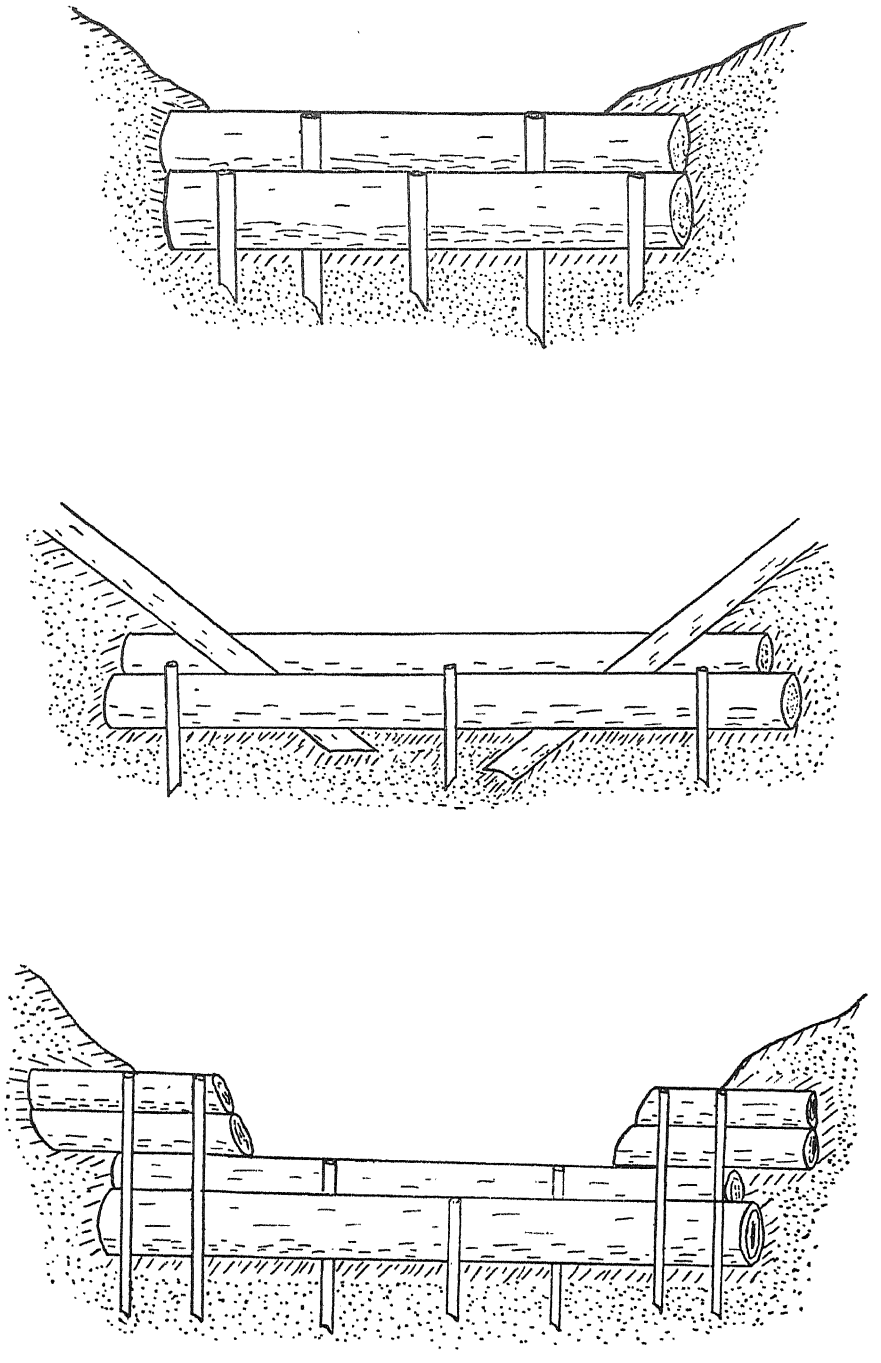


FIG. 12.—Log weirs.

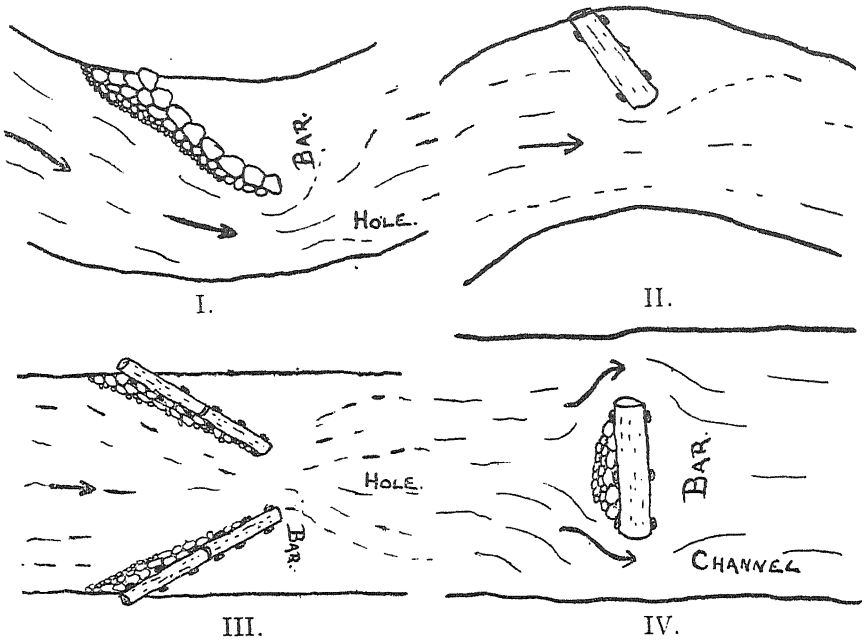


FIG. 13.—Deflectors. I. Boulder deflector. II. Log deflector. III. Double log deflector. IV. Incorrect placing of a log deflector.

LITERATURE CITED

1. 1915. ALVORD, J. W. and C. B. BURDICK: The Illinois River and its Bottom Lands. Rept. Illinois Rivers and Lakes Comm. p.p. 64-83. Springfields, Illinois.

2. 1926. DIESSNER, BRUNO and PAUL ARENS: Die Kunstliche Zucht der Forelle. J. Neumann, Neudamm.

3. 1922. EMBODY, G. C.: Concerning high water temperature and trout. *Trans. Am. Fish Soc.* Vol. 51, p.p. 58-64.

4. 1936. GILL, LEONARD E.: A First Guide to South African Birds. Maskew Miller Ltd., Cape Town.

5. 1940. HEY, D.: A Preliminary Report on the Reproduction of Trout in the Steenbras Reservoir. Cape Piscatorial Society, Circular No. 35.

6. 1929. HERRE, ALBERT W.: Bangos Culture in the Philippine Islands. *Jour. of Science*, Vol. 38, No. 4, Manila.

7. 1932. HUBBS, C. L., JOHN R. GREELEY and C. M. TARZWELL: Methods for the Improvement of Michigan Trout Streams. Univ. of Michigan, Ann Arbor Mich.

8. 1938. HUBBS, C. L., and R. W. ESCHMEYER: The Improvement of Lakes for Fishing. Univ. of Michigan, Ann Arbor, Michigan.

9. 1932. KREUZ, A: Teichbau und Teichwirtschaft. J. Neumann, Neudamm.

10. 1939. LOWDERMILK, W. C.: Fish Ponds and Fields in Rotation. *Soil Conservation*, Vol. V, No. 5.

11. 1916. NEEDHAM, J. G. and J. T. LLOYD: The Life of Inland Waters. The Comstock Publishing Company, Ithaca, New York.

12. 1940. NEEDHAM, PAUL, R.: Trout Streams. Comstock Publishing Company, Ithaca, New York.

13. 1928. SCHILLINGER, A.: Biological Purification of Sewage in Fish Ponds. Vom Wasser, p.p. 200-213, Berlin.

14. 1934. STRELE, GEORG.: Grundriss der Wildbachverbauung. Julius Springer, Wien.

15. 1920. SMOLIAN, K.: Merkbuch der Binnenfischerei. Denter und Nicolas, Berlin.

16. 1932. SURBER, EUGENE, W.: Controlling Vegetation in Fish Ponds with Sodium Arsenite. Investigational Report No. 11. Government Printing Office, Washington D.C.

17. 1937. VIOSCA, PERCY. M. S.: Pondfish Culture. The Pelican Publishing Company, New Orleans, U.S.A.

18. WIESNER, R. E.: Lehrbuch der Forellenzucht und Forellenteichwirtschaft. J. Neumann, Neudamm.

19. WILLIS, J. C.: A Dictionary of the Flowering Plants and Ferns. The University Press, Cambridge.

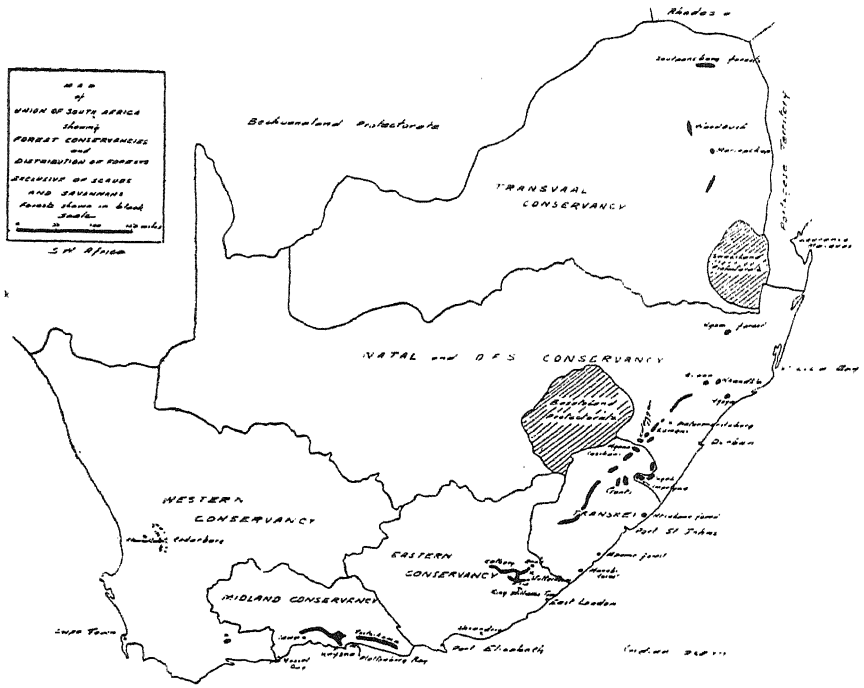
THE EXPLOITATION OF THE INDIGENOUS FORESTS OF SOUTH AFRICA

By N. L. KING

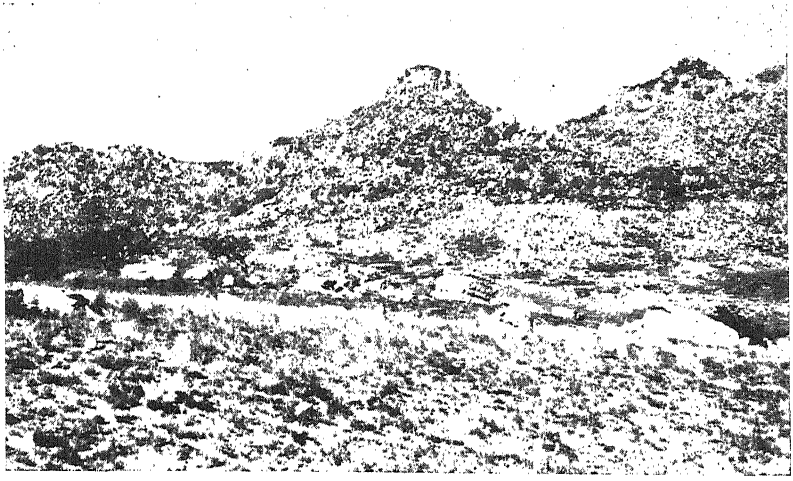
(Chief Management Officer, Division of Forestry.)

Introduction

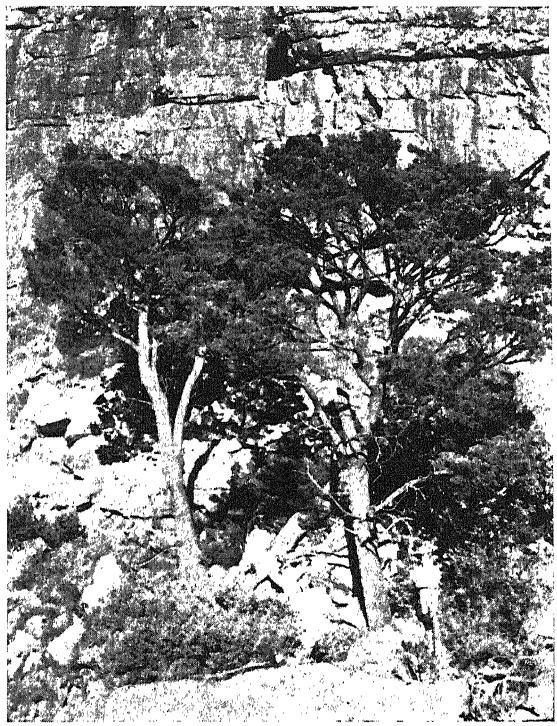
OUR indigenous forests, exclusive of scrubs and savannah, occupy an area of less than 0.2 per cent. of the total extent of South Africa. The forests are confined to a belt along the south and east sides of the country. Although their area is insignificant in relation to that of the country they have nevertheless played an important role in its development by yielding timber for housebuilding, for the manufacture of waggons and carts and for the needs of the gold and diamond mines at a time when other sources of supply were not available. Speaking generally it may be said that exploitation has taken place at a rate far beyond that on which a sustained yield could be maintained with the result that the accumulated increment of centuries of growth has been used up in a relatively short space of time and has left many forests in an exhausted condition.



Distribution of indigenous high forest in the Union of South Africa. Forests indicated by heavy black lines.



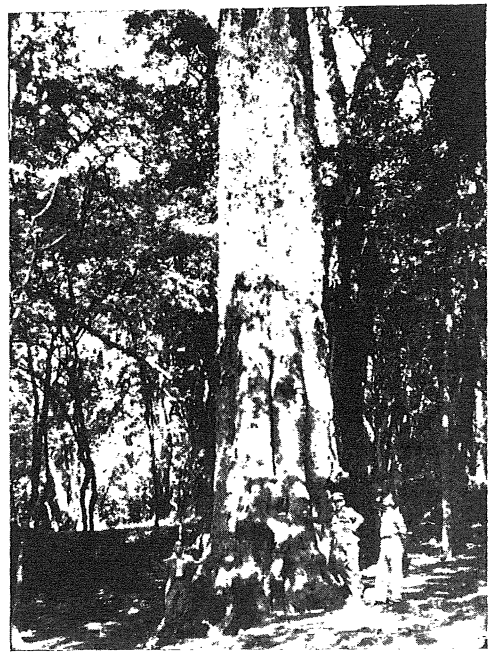
Type of country inhabitated by Clanwilliam cedar.



Two well grown Clanwilliam cedars.



Pleurostylia capensis in kloof in Block J Weza, Natal. Girth at B.H. 21 ft. 6 in. Height to first branch 27 ft.



"The Monarch of the East."
Common yellowwood (*Podocarpus falcatus*), Auckland forest near Hogsback. Girth at B.H. 28 ft. 3 in. Estimated height to first branches 40 ft.

A sketch of the exploitation, as far as it is known to the writer, may not only be of interest but may also prove helpful at some future date to the coming generations of foresters. With these objects in view the following notes have been put together. The writer has made free use of official reports and is also indebted to those who have kindly furnished information which would otherwise not have been available.

For the sake of clarity the forests in each Conservancy have been treated separately.

Western Conservancy

This Conservancy comprises a large area in the Western Cape Province but the indigenous forests within this area are hardly worth speaking about. Cedars *(Widdringtonia juniperoides)* are met with on the Cedarbergen near Clanwilliam. They occupy a zone between 3,400 and 4,800 feet above sea level and are found on kranses or between boulders which afford protection against veld fires. The present stocking of large sized trees averages only one or two per acre. Although the number of large trees has no doubt considerably diminished since europeans settled in the neighbourhood, the Cedars never formed true forest as popularly understood by the term. The trees are short-boled with large spreading crowns and yield a light fragrant and durable wood which is used chiefly for coffin boards and fence poles. At present only dead trees are disposed of, the yearly output amounting to a few hundred cubic feet. It is of interest to note that in a closed receptacle such as a cupboard or desk the volatile oil from the wood settles on metal work and printer's ink, clogging up locks and hinges and gumming together the pages of books.

Round about Cape Town and along the mountains to the east, patches of forest aggregating about 600 acres are met with in sheltered positions. These forests contain many of the species represented at Knysna but with the exception of a few isolated patches in inaccessible kloofs have long been denuded of serviceable timber.

Midland Conservancy

This Conservancy comprises part of the midlands of the Cape Province but the forested portion consists of a narrow strip about 120 miles long between George and Clarkson. The forests occur in patches along the foothills and spurs of the mountains and in the deep river gorges. In their primeval state they were probably as fine if not finer than any other forests in South Africa. The total extent of forest in this strip is roughly 153,000 acres of which 103,000 remain in possession of the State. Of the latter, 92,000 acres are classified as timber producing forests and the remainder as scrub. A good deal of forest was destroyed by the great fire in 1869 which devastated about 100 miles of country between Mossel Bay and Blaauwkrantz.

Exploitation began as far back as 1772 when the Dutch East India Company established a "timber post" alongside the George forests to supply the settlement at Cape Town with timber. A similar post was established at Plettenberg Bay six years later presumably with the object of reducing costs by using the sea instead of overland transport. Little or no control appears to have been exercised over felling operations for in 1805 the Resident at George was instructed to look to the preservation

of the forests and in 1811 the large forest at Harkerville near Plettenberg Bay was said to be nearly exhausted. After the final cession of the Cape to Great Britain in 1806, the timber post at Plettenberg Bay was run by the Admiralty until it was closed down in 1820. From then until 1847 little is known about the history of the forests. They were placed under the jurisdiction of Magistrates who appear to have contented themselves with the issue of licences to those who applied. The reckless felling and enormous waste that took place resulted in the closure of the forests against further cutting in 1847. For reasons not known the Government then decided to sell the forests. According to published returns 158 lots were surveyed and upset prices were fixed at from three to fifteen shillings per acre. Fortunately not many were disposed of before the decision was reversed. During the period the forests remained closed a Conservator and a few Rangers were appointed to prevent further depredations. The closure of the forests gave rise to a storm of protest and in 1856 they were re-opened. Major William Hope, Auditor General, after consultation with the magistrates concerned, drew up a set of forest regulations which were promulgated in 1856. These were the first regulations drawn up in the Colony for the management of the forests. At the same time a conservator was also considered necessary in the Tzitzikama. The choice fell on Captain Harison to whom the Department owes a great deal. Under the regulations referred to, the tariff for wood was fixed at £1 per waggon load which could consist of any one of the following:—

2 complete loops, i.e. sufficient wood to build two waggons.
80 cu. ft. of yellowwood in the log or 50 planks 20 ft. x 12 in. x 1 in.
50 cu. ft. of Stinkwood i.e. 10 planks 20 ft. x 12 in. x 3 in.

It will be noticed that, in the case of planks, only lengths of 20 feet were specified. This was the recognised length into which logs were cut, shorter pieces being allowed to rot. As will be seen later the same wasteful method prevailed in the forests of British Kaffraria.

The regulations remained in force until 1875 when they were amended. A further amendment was made in 1883 after Count de Vasselot de Regné had inspected the forests. The Count was an eminent French forest officer whose services were obtained under contract to examine the forests and prescribe broad principles for their management. The detailed instructions issued by him have formed the basis on which the forests have since been managed. The forests were divided into blocks and each block into 40 sections, one of which was to be worked each year. Only mature, over-mature and defective trees and undesirable species were marked for felling. The scheme was quite sound in principle but two points which subsequently had a profound bearing on its success were overlooked. The first was that woodcutters remained the sole arbiters of the trees to be felled. They picked out those they desired to purchase and left the remainder. During the period 1889-1903, 386,439 trees were marked for felling but only 56 per cent were sold. As no facilities existed for dealing with unsold trees by departmental means they were perforce left to clutter up the forests and impede regrowth. The second point was the ever increasing number of woodcutters who were dependent upon the forests for their livelihood. As the sons of these people reached manhood they took to woodcutting on their own account and in course of time the number grew to such an extent that only by overcutting

could their needs be satisfied. How the problem was finally disposed of will be referred to later.

The year 1888 saw the passing of the Forest Act No. 28 of 1888 which was the first Cape legislation dealing specifically with forests and which conferred on forest officers much needed powers. Amended regulations framed under the provisions of this act were issued in 1891.

For many years after the Count's memorandum on the systematic management of the indigenous forests, trees were sold only in what were termed "public sections." In these sections anyone who wished to buy timber could do so. As the result of an application by one, Templeman, it was decided in 1891 to sell sections outright to those who applied for them. Under this method all the trees marked for felling could be purchased by one individual on cash payment of their standing value, subject to a rebate of a certain percentage of the value. The main advantage claimed for outright sections was that all marked trees would be purchased as opposed to only sound trees and certain species in public sections. The two methods of sale were in operation until 1912. During the following year the sale of outright sections was discontinued. A drastic change in policy was then brought about by the passing of an amended Forest Act (Act 16 of 1913) which made provision for dealing with the woodcutter problem. Under this act powers were obtained to draw up a list, to which no more names would be added, of those entitled to be registered as bona fide woodcutters. Wood from State forests in the Midland Conservancy was then sold only to those whose names appeared on the list, each of whom was allowed a certain quota per annum. The registered wood-cutters thus became a privileged class and obtained a complete monopoly over the forests but the scheme had the advantage that the annual cut would, within measurable distance, be reduced to the capacity of the forests. Matters were shaping to this end until 1925/26 when, for political reasons, the quota was raised and for years the annual cut again far exceeded the capacity of the forests. The matter was brought to a conclusion in 1939 by the deregistration of woodcutters and resort to departmental working. The first step was drastically to reduce the annual cut. This action has stayed the utter ruin of the forests but a very long time must elapse before the damage can be repaired.

Much of the timber cut in the George-Knysna-Tzitzikama forests was sawn or partly fashioned by hand. Apart from sleepers which were sold to the sleeper factory, woodcutters disposed of sawn and partly manufactured wood to timber merchants whose mills turned out the finished products.

The first mill at Knysna was erected about 1873 by Messrs. Lloyd & Co. who disposed of it in 1892 to the Knysna Forest Co. In 1894 it was taken over by Messrs. Geo. Parkes & Sons by whom it is still operated. In 1876 the last sale of forest lots took place. Messrs. Thesen & Co. bought lot R.R. of 1,079 morgen and an adjoining lot of about the same size. Both of these lots are situated at Bracken Hill, where Messrs. Thesen & Co. erected a small steam mill. This mill was improved from time to time and in 1914 was described by Brisbane, a retired Railway official, as "a most up to date mill driven by electric power." It was dismantled in 1921 and transferred to Knysna where it is still in operation. About 1882 Templeman also erected a mill at Knysna. It was burnt down during 1915 and not re-established. Templeman also operated a

small portable mill at Deepwalls from about 1890 to 1905 and Messrs. Thesen & Co. and McFarlane had similar mills at Gouna.

After the cancellation of the Dunn contract for sleepers in the early eighties the Government took over the plant at Gouna and incorporated it in the sleeper factory at Knysna. The factory was subsequently transferred to Mossel Bay and later to George. Some machinery appears to have been left at Gouna for Fourcade in 1887 suggested the establishment of a departmental mill and mentioned that "machinery is already available." A little sawing seems to have been undertaken but in 1890 the mill was closed down.

The first mill in the Tzitzikama was a portable plant erected in the early eighties by a man named Hudson. This plant was hauled through the gorge of the Storms River before the road was made. Anyone acquainted with the nature of the country will appreciate the magnitude of the task. The plant was subsequently moved to Blaauwkrantz. It was taken over by Victor by whom it was operated until about 1916. About 1895 another mill was erected near Storms River by Smith Holmes. The venture did not prove a success and the plant was taken over by Messrs. Mangold Bros. in 1899. It was moved to a site near the mouth of the Storms River where partly manufactured wood could be loaded on to small coasting vessels. This mill is still in operation but Messrs. Mangold Bros. are contemplating giving up this side of their business. In 1902 a mill and manufacturing plant was established at Coldstream by Witcher. A large variety of articles were turned out including building timbers, joinery, waggon woods and handles. The mill is still standing but operations are now confined mainly to the production of novelties and a little furniture. About 1912 Dr. Fourcade started a small mill at Wit Els Bos with the primary object of sawing hardwoods. On account of the change in policy in 1913 in the sale of wood from State forests he found himself unable to continue and closed down the mill in 1915.

None of the mills referred to ever operated on a large scale for the reason that the annual cut in Government forests did not exceed about half a million cubic feet, a large proportion of which was worked by hand. As we have seen most of the mills have faded out of the picture in consequence of the gradual exhaustion of the forests.

The forests under discussion have been worked for a much longer period than any others in South Africa. The surprising feature is that they have lasted so long. About 19 per cent. are still regarded as exploitable, 56 per cent. have been overworked and 25 per cent. reduced to kreupelbos which will take centuries to recover. As far as can be ascertained the total yield has been about 25 million cu. ft. of timber of which roughly 50 per cent. consisted of yellowwood, 4¼ million of Stinkwood and 8¼ million of waggon woods, Kamassi and other woods. An exhaustive stock-taking carried out during 1928-30 in forests still regarded as exploitable showed an average stocking of only 533 cu. ft. of mature timber per acre of which not more than about 2½ cu. ft. per acre per annum could, with safety, be marked for felling. Since then the position has become worse. The stock-taking also emphasised the pernicious effect of culling the forests for certain species only. Ample evidence was obtained to show that the proportion of less valuable species has increased and that unless this downward tendency is checked these less valuable but more aggressive species will ultimately monopolise the soil.

Eastern Conservancy

This Conservancy is bounded on the west by the Gamtoos and Groot rivers and on the east by the Great Kei, White Kei and Indwe rivers. The forested area comprises a belt about 20 miles wide on the western side gradually widening towards the east where it extends 100 miles or more up the valleys of the Great Fish and Great Kei rivers. In this belt the total extent of State owned forest is about 151,000 acres. By far the greater part consists of scrub or mimosa which cannot yield more than poles and firewood. On the Elands River, Great Winterhoek and Zuurberg mountains forests of a dry type are met with but are not of high value for timber. Similarly the coastal forests are of a scrubby nature except at Alexandria where a large proportion of the growing stock is represented by large but squat yellowwoods. Real timber forests aggregating about 65,000 acres occur only along the moist seaward slopes of the mountains stretching from Bedford to Stutterheim more particularly on the Amatolas and subsidiary ranges in British Kaffraria. It is in these mountain forests that the bulk of exploitation has taken place. Elsewhere the forests have been worked mainly for poles except at Alexandria where a good deal of boxwood *(Buxus macowani)* has been exploited for export.

In the Eastern Conservancy we begin to see the effects of improvident treatment of the forests by natives, who migrated down the east coast and by 1686 had penetrated as far west as the Keiskama river.

For many years after the landing of British settlers at Port Elizabeth in 1820 and their settlement in the districts of Bathurst and Albany the Great Fish river formed the recognised boundary of Cape Colony. As a result of frequent border warfare the country between the Great Fish and Great Kei rivers was annexed in 1835 and declared a separate province called the Province of Queen Adelaide. This province existed for only a year for, in consequence of a change of policy, it was abandoned and the Fish river again adopted as the boundary.

On his return in 1835 after driving the natives over the Kei Sir Benjamin D'Urban bivouacked on the left bank of the Buffalo river alongside Brownlee mission station which was established in 1826. He was much impressed with the fertility of the land and "the clear, rapid and beautiful river" and proclaimed a township which he named King William's Town. This township was destined to become the capital of British Kaffraria. Following further trouble with the natives the country between the Fish and Kei rivers was again occupied by British forces in 1847 and the portion between the Keiskama and Kei rivers was given the name of British Kaffraria by the Governor, Sir Harry Smith, whose name is writ large in the annals of the history of that area. Kaffraria became a dependency of the Crown and remained as such until 1865 when for economic reasons it was incorporated in Cape Colony.

Exploitation of the Amatola forests must have been begun by hand sawyers shortly after 1847. In 1852 Messrs. Haynes and Small established a water driven sawmill just outside the Pirie forest at a point on the Buffalo river below the present Maden dam. The Government tariff for wood was based on 50 shillings per saw pit per quarter, the requirements of the mill being regarded as equivalent to six saw pits or £60 per annum. For this amount Messrs. Haynes and Small could take as much timber as the mill could handle and fell just what they required. As the mill products consisted mainly of building timbers, flooring and

ceiling, the timber most sought after must undoubtedly have been yellowwood. Small complained to Brown, the Colonial Botanist, who visited Kaffraria in 1863, about the lack of control over the hand sawyers and declared that for every tree paid for they surreptitiously cut four more. He also deplored their wasteful method of cutting logs into 20 ft. lengths and leaving shorter pieces to rot in the forest. Brown evinced great interest in the preservation of the forests and subsequently wrote a memoir on the subject. This memoir was considered by a select committee appointed by the Legislative Council in 1865 who reported that "sufficient information was obtained to satisfy them that there exists a necessity for a change in the system of management of all forests in the various parts of the Colony." Shortly afterwards Captain Baron de Fin was appointed Conservator of Forests with headquarters at Keiskama Hoek. What staff was allotted to him is not known but, according to the report of the Superintendent of Woods and Forests for 1881, it consisted, at that time, of one European ranger and six native subordinates. Melville, the Assistant Surveyor General, expressed grave doubts about the employment of native rangers and de Fin complained that they "have not sufficient capability to perform the work which their duties demand" and that "their position among the tribes cannot fail to be a very delicate matter where the interests of the forests are in direct opposition to those of their relatives and friends."

With a staff of this description it was quite impossible for de Fin to exercise more than nominal control over the many forests scattered along 80 miles of difficult mountainous country accessible only by native paths, cattle tracks and slip paths. To add to his difficulties the boundaries of the forest reserves were not defined and it was consequently impossible to tell which were Government forests and which were not.

The woodcutters gradually spread all along the Amatolas and into the districts of Victoria East and Stockenstroom, where the forests fell under the jurisdiction of the respective Magistrates and not under the Conservator. Woodcutters naturally confined their activities to the lower and more accessible parts of forests which were denuded of merchantable trees. To-day these parts resemble scrub and give one the erroneous impression that they never contained large sized timber trees. As far back as 1878 de Fin stated that "the forests in this (King William's Town) division are still in a great degree suffering from the damage done to them 20 years ago and for their recovery I would suggest that Government be pleased to give up altogether the revenue accruing from the sale of timber and close up all the wards."

The Government was not pleased to give up this source of income for the declared policy was that expenses connected with the forests should be met from the revenue they yielded. Probably de Fin thought that by closing the forests this would stay the damage which he was unable to check with the limited staff at his disposal. It is of interest to note that two years later, in spite of the Conservator's recommendation, a contract was given out for the supply of 60,000 sleepers from the Tyumie forests near Alice. Count de Vasselot de Regné recorded that, in 1881, ten thousand of the sleepers had been supplied and three thousand more had been prepared. Presumably they had to be transported to East London by ox waggon, a distance of roughly 90 miles, for shipment to Cape Town. A large number of telegraph poles were also cut from immature sneezewood trees. Hutchins gave the number as 50,000 and

stated that they "proved to be practically worthless as they consisted mainly of sapwood."

The forests suffered not only at the hands of woodcutters but also from fire and the activities of the natives. Under normal conditions our indigenous forests are well-nigh impregnable to fire but the large accumulations of dry wood resulting from heavy fellings allowed grass fires to enter and spread through certain forests. In this way a large part of the magnificent Auckland forest near Hogsback was destroyed in 1889. The Katberg forests, said to have been finer than any in the Amatolas, were gutted several times. Writing in 1881 the Count referred to the desolation and said "the land still covered with trees dry at their base is overrun with bush and creepers amongst which we could discover no natural sapling of a timber tree." Atmore the Forest Ranger in Stockenstroom division estimated that during 1883 one thousand acres of forest were destroyed by fire.

The damage caused by natives strikes at the very existence of forest. They have no use for large sized trees but require millions of saplings for the construction of huts. In this way forests are denuded of the future crop and, due to grazing and the introduction of grasses which follow the removal of undergrowth, the full grown trees gradually succumb and in course of time disappear. In other cases forests are deliberately destroyed to make way for mealie gardens. Melville who had an intimate knowledge of the country stated in 1883 that "I have noticed considerable extents which I knew years ago to be covered with magnificent forest trees now turned into bare hill-sides with gardens dotted over them." Hutchins writing on the same subject said "in nearly every valley of the Amatolas the lowest and often that portion of the forest which carries the best timber is eaten into and honeycombed by mealie gardens." From this brief sketch it will be seen that before an adequate staff of forest officials had been built up many of the Amatola and neighbouring forests had suffered grievous injury. With the appointment of Hutchins of the Indian Forest service in 1882 as Conservator, matters began rapidly to improve. The Government had begun to take a more lively interest in forestry and Hutchins was thus able to dispense with the services of native rangers and appoint six European forests in their stead. Being possessed of unbounded energy and enthusiasm he vigorously set about the beaconing and demarcation of the forests. He then put into operation the system of management laid down by Count de Vasselot de Regné. In a short time he had the woodcutters well in hand. Some of them resented the curtailment of their liberty of action and trekked off to the newly acquired territories in the Transkei to escape the forest regulations.

For about a decade after Hutchins's assumption of duty timber was disposed of only from public sections. Sawmilling was then commenced on a fairly large scale and to meet the altered conditions the system of selling sections outright was introduced. During 1892 a man named Urry set up a mill at Isidenge and a year later was followed by Howse who had, for many years, supplied the Kimberley mines with props from a privately owned forest near Bedford. Howse subsequently operated on a larger scale than anyone else in the Eastern Conservancy but judged by the standard of mills now operating in plantations, his consumption of timber was relatively small, the quantity in logs not exceeding 150,000 cu. ft. a year.

The Isidenge forests were worked out in 1897 and both Urry and Howse had perforce to move their mills elsewhere. Howse transferred his mill to "Artillery Sections" in upper Cwencwe which is a continuation of the Pirie forest. He operated there for only a couple of years and then moved to Upper Kubusie where he remained for about 8 years. He then undertook the exploitation of the Upper Pirie—Evelyn Valley forest. This was a difficult undertaking and necessitated the construction of 2½ miles of light railway from the mill site alongside Maden dam to a loading site in the forest. It was originally estimated that the forest (about 1,000 acres) would yield sufficient timber to keep the mill going for 20 years. Operations started in 1909 but by 1917 the forest was worked out. The mill then closed down and Howse left the Conservancy. Altogether 16,523 trees were marked for felling in the Pirie-Evelyn Valley forest and yielded 1,339,000 cu. ft. of timber consisting of 76 per cent. yellowwood, 23 per cent. of waggon woods and 1 per cent. other species. Most of the timber it is sad to relate was sawn for mining purposes.

Urry also moved his mill to Artillery Sections and then sold it to Colonel Mullin who transferred it to the eastern portion of the Pirie forest called the Cwencwe, where after the Kaffir war of 1877 he was granted a farm of 300 acres, most of which consisted of forest. A number of smaller mills operated in this area some wholly or partly on timber obtained from private sources and others dependent entirely on Government forests. One of the former was run by Messrs. Haynes Bros. whose father, about 1876, acquired a slice of roughly 1,000 acres of virgin forest in the Pirie. This mill functioned until 1916. The property was then sold to a Johannesburg company called the Exchange Yard (Pty.) Ltd. who cut all serviceable timber and then disposed of the ground. About 617 acres of the worked out forest was purchased by Government in 1922. A man named Pautz also owned property containing a good deal of forest which, with supplementary supplies of wood from Government forests, supported a mill for many years. Ultimately supplies from both sources became exhausted and the mill was forced to close down. In 1929 Government purchased about 426 acres of the ground. A couple of small mills also operated at Qacu to the east of Stutterheim but the extent of forest was quite insufficient to keep them going for more than a few years.

It should be mentioned that, in order to assist millers and hand sawyers to dispose of yellowwood, a creosoting plant for the treatment of railway sleepers was established at Kingwilliamstown in 1898. During the first three years 42,171 sleepers were delivered to the plant but in 1902 the number fell to 2,559 and, as a result, the plant was closed down a couple of years later.

It has long been known that the Amatola and neighbouring forests were practically worked out. In order to sum up the position a careful examination of each forest was made during 1938. This examination showed that, by area, 88 per cent. should be closed to further working except in regard to dead and windfallen trees. Light marking, confined mainly to moribund trees, is permitted in the forests which are still exploitable except Schwartzwald and Upper Wolf River near Hogsback. Parts of these two forests, aggregating 2,600 acres, are still more or less virigin and owe their escape from the axe to their inaccessibility. Howse contemplated the erection of a mill in their vicinity but abandoned the project after he had thoroughly investigated ways and means of

extracting the timber. A working plan drawn up in 1939 for the management of these forests showed that the volume of marketable wood averages only 1,600 cu. ft. per acre of which 59 per cent. consists of common and real yellowwood. The plan is being given very careful consideration in order to ensure that the prescriptions will maintain the present character of these forests. It may be mentioned that portion of the Schwartzwald has been set aside as a nature reserve in which no felling at all will ever be permitted. A similar reserve has been created in that portion of the Auckland forest, below Hogsback, which escaped fire and axe. This reserve contains the giant common yellowwood called "The Monarch of the east" which measures 28 ft. 3 in. in girth at breast height with a clear bole of about 40 feet.

From the foregoing it will be seen that cutting has been taking place in the mountain forests of this Conservancy for over 90 years. It would probably not be very wide of the mark to say that they have yielded upwards of 12 million cu. ft. of timber. Figures for the period 1892 to 1938-39 give the total volume sold in the whole of the Eastern Conservancy as 7,451,000 cu. ft. The bulk was, by far, derived from the mountain forests and was made up of 67 per cent. yellowwood, 25 waggon woods, 3 sneezewood and 5 per cent. of other species.

Transkeian Conservancy

This Conservancy is bounded on the west by the Great Kei, White Kei and Indwe rivers and on the east by Natal. The several territories comprising the Transkei were annexed by the Cape Colony between 1878 and 1894, except an area of 34 square miles at Port St. Johns which was purchased from Faku, Chief of the Pondos, in 1878. Behind the purchase of this ground lies an interesting story. A colony of Germans had established themselves near the mouth of the Umzimvubu river. The Cape Government feared that this colony would give rise to international complications and in order to circumvent any such development, stepped in and bought the ground. Since then it has remained a European area.

Four types of forest may be distinguished in the Transkei, namely coast forests, mimosa and scrub, mountain forests and outlying patches of inferior quality high up on the Drakensberg. With the exception of the Manubi, Mpame and Ntsubane, which are of a high quality and contain or contained a good deal of yellowwood, the coast forests are of a low scrubby type. They have, however, yielded considerable quantities of sneezewood and boxwood *(Buxus macowani)* and contain many other species of considerable potential value. As in the case of the Eastern Conservancy, the mimosa and scrub contain little beyond poles and fuel but are valuable as a protection against soil erosion. On the other hand, the mountain forests along the escarpment between Cala and the Natal border are of high quality. In these forests yellowwoods predominate and many other species of high economic value are met with. Fully 85 per cent. of the total volume of timber cut in the Transkei was derived from these forests. The outlying patches on the Drakensberg also contain a good deal of yellowwood but are of relatively poor quality and were never more than of local importance.

With the exception of portion of East Griqualand, the small area at Port St. Johns, commonages allotted to towns and villages and a few pieces of privately owned ground, the Transkei is a native area and is being developed for the natives and by the natives under the direction of european administrative officers.

Shortly after the establishment of a forest service in 1888, demarcation of the more important forests was taken in hand. The early demarcations included a certain amount of grassland to provide grazing for cattle employed on work in the forests and for future afforestation, the necessity for which was foreseen by the demarcating officers. This policy was amended in 1915 and from then onwards demarcations included a strip of grassland only 20 yards wide along the perimeters of forests. Altogether 153,000 acres have been demarcated. of which 60,000 acres are situated on the mountains.

A large number of forests were set aside in each district for the domestic uses of the natives. What the area originally amounted to is not known but a rough survey carried out in 1936 showed the remaining extent, exclusive of forests in the districts of Libode, Mount Fletcher and Matatiele, to be about 94,000 acres. The original area must have been considerably larger for many forests have been deliberately destroyed to make way for mealie gardens and others have disappeared as a result of grazing and the gradual destruction of the undergrowth. The destruction of forests has been most rapid in the midlands and in parts of the coastal belt where tracts shown as well wooded on a map compiled sixty years ago are now bleak and treeless.

The felling of timber actually began long before the establishment of a forest service in the Transkei. A number of European and Hottentot sawyers who resented the introduction of forest regulations in Kaffraria and neighbouring districts trekked across the Kei where, on payment of 5 shillings per month, they could cut where they liked, what they liked and as much as they liked. When control was tightened up some moved off into Pondoland, where they could do as they liked on payment of £5 per saw per annum to the Chiefs. Their freedom of action came to an end with the annexation of Pondoland in 1894. How many Europeans were engaged in woodcutting in the several territories of the Transkei at the time of annexation is not known. A list drawn up in 1918 gave the number as 69. In addition, 73 Griqua and native sawyers were engaged either on their own account or as assistants to Europeans. The list was drawn up mainly for the purpose of preventing any more Europeans from taking up woodcutting in the Transkei. Since then the number has gradually been reduced and now stands at 23. Up to 1936 no restriction was placed upon the quantity of timber any individual sawyer could work during a year and, by employing a number of native assistants, some worked well over 2,000 cu. ft. per annum. This was overcome by fixing a quota of 1,000 cu. ft. a year for each of those whose names appeared on the list. The culling of the forests for yellowwood or stinkwood only was done away with as well as the practice of marking trees for felling only in forests situated near where woodcutters happened to reside. This policy slowed down the rate of cutting in the indigenous forests and has been the means of turning the attention of woodcutters to plantation grown timber. These sawyers in the early days fulfilled a much needed want by supplying the Transkei and bordering districts with building timbers and waggon woods but like the woodcutters at Knysna were responsible for a good deal of the overcutting that took place in the forests.

When the forest service assumed control in the Transkei it was faced with the problem of many forests that had been reduced to kreupelbos. Heywood, in 1901, estimated that 52 per cent. of the mountain forests

had been worked out and should be closed to further cutting. An investigation carried out by the writer four years ago showed that the proportion had risen to 57 per cent. and that in nearly all of the remaining forests further cutting should be confined chiefly to the under-storey consisting of broad-leaved species. As a result of this investigation the annual cut was drastically reduced, the cut being fixed at about 2½ cu. ft. per acre per annum. As far as data are available this is slightly below the increment of merchantable species and thus allows a small margin of safety.

Speaking generally the forested area in the Transkei is made up of small patches scattered over a wide area. Under such conditions forests can best be worked by hand sawyers. Fully 84 per cent. of the timber has consequently been sawn or fashioned in this way. A few mills operated at various times with but one exception were forced to close down by the exhaustion of the forests on which they depended for raw material. The first was started at Manubi in 1890 by Trow. This forest is situated in the Kentani district at a distance of about 3 to 4 miles from the sea. Unlike most of the coast forests it contained a considerable amount of yellowwood which formed the main attraction. The mill was burned down in 1904 and was not re-established. As far as can be ascertained the total quantity of timber exploited amounted to about 210,000 cu. ft. of which 71 per cent. consisted of yellowwood.

The next mill was established by E. T. Ball during 1904 alongside Tonti forest. This forest is 852 acres in extent and is situated a few miles south-east of Mt. Ayliff. It was wonderfully rich in yellowwood *(Podocarpus Henkelii* and *P. latifolius)* stinkwood and sneezewood and was regarded as one of the most valuable in Cape Colony. A working plan prepared in 1924 showed that the unexploited portion contained 2,600 cu. ft. of merchantable timber per acre made up of 80 per cent. yellowwood, 15 stinkwood and 5 per cent. of other species. Stinkwood reached a large size, one tree yielding as much as 221 cu. ft. of sound timber. The mill operated continuously until 1922 when it was closed down for a few years. It was taken over by the late J. Cole of Riverside during 1925-26 and functioned until 1931-32 when operations finally ceased. Records are somewhat unreliable but as far as can be ascertained approximately 782 acres were exploited and yielded 454,000 cu. ft. of timber or round about 600 cu. ft. per acre. In order to preserve portion of the virgin forest an area of 70 acres was set aside as a nature reserve in which no felling will be permitted. During April, 1938, Tonti was struck by a cyclone which razed to the ground two strips of forest aggregating about 80 to 100 acres. The greater part of the wood thrown down was salvaged by hand sawyers.

During 1917 Ball also established a mill at Insikeni near Riverside. This mill was taken over by Cole in 1923 and functioned until 1928 when it was closed down. Its timber supplies were drawn from the Hoha and Dlokolwana forests in which 486 and 569 acres respectively were exploited and yielded 639,000 and 345,000 cu. ft. of timber. Roughly 80 per cent. consisted of *Podocarpus Henkelii,* 7 per cent. *Pod. falcatus* and 13 per cent. of broad-leaved species which included a small amount of Stinkwood. In order to ascertain whether satisfactory regeneration would be obtained by clear felling, a strip in the Hoha forest was clear cut. The result has, however, been anything but satisfactory as shrubs, creepers and weeds have taken possession of the soil. It would appear that many

more years must elapse before tree species again begin to assert themselves in the clear cut area.

From 1916 to 1922 attempts were made to exploit the coast forests at Port St. Johns. These forests are of a sub-tropical type and are composed almost entirely of hardwoods. In 1916 Ball entered into an agreement to purchase timber from the Nenga forest on the east bank of the Umzimvubu river. He proposed erecting a mill but it did not materialise and the timber extracted was worked by hand. Many difficulties were met with and in 1922 operations were abandoned. Altogether about 1,000 acres of forest were worked but the yield was only 48,000 cu. ft. A man named Shand also entered into an agreement in 1917 to purchase timber from the Ngogo forest on the west bank of the river. The "Ngogo Forest Co. Ltd." was subsequently formed to exploit the forest and was later taken over by Charnley Bros. Here again difficulties were met with and operations ceased in 1922. About 116 acres of the forest were worked and yielded 69,500 cu. ft. of timber in the log.

The total amount of timber cut in demarcated forests in the Transkei during the period 1889 to 1938-39 is recorded as 9,488,000 cu. ft., the bulk of which consisted of yellowwood. Detailed figures for portion of this period show that the yield from the mountain forests comprised 82 per cent. yellowwood, 11 waggon and furniture woods and 7 sneezewood. A number of these forests still contain a good deal of stinkwood, the annual cut of which is now being strictly regulated.

As far as the mountain forests are concerned the present position is that 26,000 acres still contain sufficient timber to justify further light working, 20,000 acres have definitely been overworked and 14,000 acres reduced to kreupelbos. It is only fair to add that a great deal of damage was caused by a frightful blizzard which swept through Kaffraria, the Transkei and Natal in 1902 and left a trail of desolation behind it. Thousands of large trees were uprooted or had their crowns broken off and many which survived the hurricane were severely damaged by the heavy snowstorm that followed. Included in the first category are certain forests, aggregating about 1,220 acres, which are still more or less in a virgin state. These include about 650 acres high up under the kranses in the Manina patrol, 70 acres of nature reserve at Tonti and 500 acres on Mgano forest reserve near Riverside. The latter contains a forest called the Maxego in which a strip survey was made during 1936 and showed the extraordinary high stocking of 7,923 cu. ft. per acre made up of 6,698 cu. ft. of yellowwood, 393 cu. ft. sneezewood, 150 cu. ft. stinkwood and 682 cu. ft. of other species. An adjoining forest called the Dikadiki (45 acres) has been set aside as a Nature reserve.

Natal and Orange Free State Conservancy

This Conservancy comprises Natal, Zululand and the Orange Free State. The last named, except for mimosas and scrub near watercourses, is devoid of indigenous trees and may consequently be left out of consideration. Natal and Zululand, on the other hand, are well wooded. The types of forest met with are much the same as those in the Transkei except that the coast forests are of a more tropical character.

European occupation of Natal began as far back as 1824 when Farewell and King endeavoured to form a settlement at the mouth of the Umbilo river where Durban now stands. Ten years later voortrekkers crossed the Drakensberg and gradually occupied the country south of the mountains.

On account of trouble with the natives and the possibility of French occupation, Natal was annexed in 1844. It became a dependency of the Cape Colony but twelve years later was given the status of a separate colony. Portion of Zululand was occupied by British forces after the Zulu war of 1879 and the remainder in 1887 except a small portion on the Northern side which was claimed by the Vryheid Republic and which was later incorporated in the Transvaal.

When farms were allotted to settlers in Natal the forests they contained were included in the grants. In this way most of the mountain forests were alienated by the Crown. Sixty years ago the area of these forests was estimated at 136,000 acres and all but 14,000 acres passed into private ownership. The fact that any at all escaped alienation was due to the fortuitous circumstances that they happened to be situated in places difficult of access or were not considered good farming areas. Many farms were taken up solely for the timber they contained and were abandoned after the forests had been plundered. In other cases the timber was worked out and native servants allowed to clear away the remaining bush and convert the land into mealie gardens. According to a report written in 1872 by the Surveyor-General, farmers maintained that only in this way could the services of their native servants be retained. Privately owned forests which escaped annihilation and which still contained timber at the time of the Great War were brought under the axe. The remnants are now being culled for chestnut and camdeboo stinkwood for yoke and chair wood.

Nearly all of the forests along the coast fell into private hands and were got rid of to make way for sugar cane which was introduced in 1847 and has since been planted in an almost continuous belt from Port Shepstone to St. Lucia—a distance of roughly 200 miles.

Enormous destruction of forest also took place on land originally set aside for native locations and on land subsequently acquired for the use of natives by the Natal Native Trust under Letters Patent of 1864. As an example it may be mentioned that a magnificent forest of 8,000 acres once stood on Zwartkops location near Pietermaritzburg. To-day, all that remains consists of about 1,500 acres of scrub which cannot yield anything more than fuel and perhaps a few poles. Even on land acquired by the Trust, the forests were mismanaged. In a report written by Sim thirty eight years ago the treatment of these forests was said to be of the "most reckless" description.

In Zululand the more important forests were fortunately retained by the Crown. Those set aside for the use of the natives have suffered considerable mutilation or have been completely destroyed. Colonel Cardew the Resident Commissioner of Zululand in a most interesting report dated 1891 deplored the destruction that was taking place by the conversion of forest land into mealie gardens. Colonel Reitz, in an article published in *The Journal of the South African Forestry Association* of April, 1939, showed that this practice was still in vogue in north eastern Zululand. Although rather late in the day it is satisfactory to be able to record that under the Native Land and Trust Act No. 18 of 1936 the management of forests on native areas is at last being placed on a sound foundation.

The only forest legislation passed by the Natal Government was Ordinance No. 4 of 1853 which consisted of five clauses and empowered the Lieutenant Governor to make provision by Proclamation "for preservation of timber and bush on the lands belonging to the Crown"

and "for regulating the granting of licences for cutting or using the same or leasing the timber or bush growing on such land." This Ordinance did not apply to Zululand where separate Proclamations were necessary. As a forest service was not created regulations issued under the Ordinance were presumably administered by Magistrates and Police. Not much success appears to have been achieved for in 1878 a Commission was appointed "to enquire into and report upon the extent and conditions of the forest lands remaining in the hands of the Crown." The Commission took a good deal of evidence which disclosed a deplorable state of affairs but Government does not appear to have taken any action in regard to the matter.

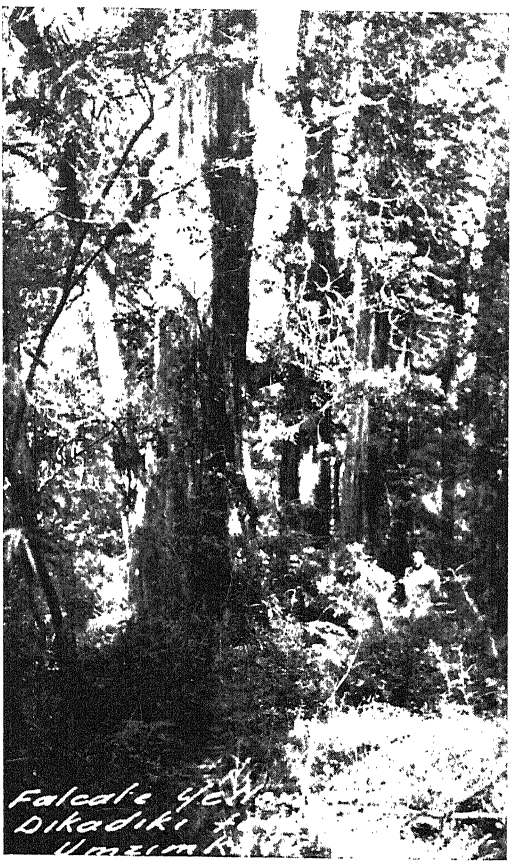
Eleven years later the forests again came into the limelight and Fourcade of the Cape forestry service was invited to visit Natal and make recommendations. He spent nine months there and after examining the forests with characteristic thoroughness issued an admirable report. He found that, with few exceptions, the Crown forests had been overworked and had also suffered enormous damage from depredations by natives and from stock which were driven into the forests for grazing and shelter during winter. On his recommendation the Natal Government decided to establish a forest service and in 1891 secured, on a three year's engagement, the services of a German forest officer named Schöpslin. One of the first steps taken by the latter was to secure the introduction into Parliament of a Bill for the better protection of the forests. This Bill was, however, rejected on the grounds of "undue rigour." Schöpslin appears to have had a small staff of foresters or rangers for he commenced the demarcation of forests and made tentative plans for afforestation. On account of the difficulties experienced in obtaining funds for these projects he resigned his post in 1892 and returned to Europe. Administration of the forests was then placed under the Surveyor-General and the forests put in charge of Police assisted in some cases by native forest guards.

Following the lead given by Fourcade, Colonel Cardew, the Acting Resident Commissioner of Zululand, took up the cudgels on behalf of the Zululand forests and in 1891 submitted a most remarkable report to the Lieutenant Governor. This report has long been frogotten but it sheds interesting sidelights on the condition of the Zululand forests fifty years ago. Colonel Cardew strongly urged that the forests should be brought under proper control and for this purpose drew up a draft Forest Act and recommended the appointment of a Forest Officer and a number of native forest guards at an estimated cost of £372 per annum. The Lieutenant Governor, while concurring with Colonel Cardew's views only authorised certain preliminary steps involving "no great expenditure." The Colonial Secretary to whom the report was submitted, stated that measures requiring increased expenditure should "only be undertaken very gradually" and added that "care should be taken, in any forest legislation, not to impose restraints on the natives, which they would feel to be irksome and unnecessary." In view of this *laissez faire* attitude it is not surprising that Colonel Cardew allowed the proposal to pass into oblivion.

In 1900 attention was once more focussed on the forests. A member of Parliament named Evans introduced a motion into Parliament asking the Government to take into consideration the formation of a Forest Department. This motion was accepted and two years later Lister of the Cape service was invited to visit Natal. His report was a most scathing indictment of the management of the Crown forests. On his



A fruitful source of soil erosion and failure of springs. Conversion of forest clad slopes to mealie gardens by natives.



Interior view of Yellowwood (*Podocarpus henkelii*) forest in East Griqualand.



First stage in destruction of forest by natives. Undergrowth removed, forest invaded by grass, and ground trampled hard by cattle.



Remnants of a forest destroyed by removal of undergrowth and grazing. Soil erosion has commenced and springs are drying up.

recommendation the formation of a Forest Department was decided upon and Sim was appointed Conservator of Forests and assumed duty in Pietermaritzburg in September, 1902. One of the first steps taken by him was the repeal of Proclamations Nos. 8 and 38 of 1896 and Zululand XI of 1894 and XV of 1895 and the issue under Proclamation No. 58 of 1903 of amended regulations based on those in force in the Cape Colony. At the time of Sim's appointment the forests were in charge of Police assisted by 25 native guards in Natal and 1 Ranger, 2 supervisors and 11 native guards in Zululand. Control of the forests was withdrawn from the Police and the services of most of the native forest guards were dispensed with. A staff was then got together constituted as follows: Natal—1 District Forest Officer, 4 full time and 9 part time Foresters; Zululand—1 District Forest Officer, 3 Foresters and 4 Native guards. Part time Foresters were farmers who were paid £2 to £5 per month as caretakers of forests in their neighbourhood. With few exceptions these part time Foresters did not prove a success and their services were gradually dispensed with.

Sim tightened up control over the forests and embarked on several afforestation schemes but before he could make much headway his post was abolished and from 1907 until Union forestry matters were dealt with by the Agricultural Department.

This briefly is the dismal history of the Natal and Zululand forests up to the time of Union. Since then the forests have been practically closed except to a few hand sawyers. Most of the Crown forests in Natal have been wholly or partly wrecked. The few exceptions are the Impetyne, Xalengeni, Ili and Xumeni. These forests, which aggregate 4,500 acres in extent, owe their immunity against serious damage solely to difficulty of access. They have been culled for sneezewood and stinkwood but still contain a good deal of yellowwood. Fourcade in speaking of the Xalengeni said that for its size it was the finest he had seen in South Africa and the nearest approach to a pure forest of yellowwood. A small portion was exploited during 1905 and 1906 and yielded about 45,000 cu. ft. of timber. Between 1928-29 and 1936-37 a couple of hand sawyers from the Transkei were permitted to work moribund and windfallen trees but this method of working has been stopped and the forest is now closed.

Exploitation of the Crown forests in Natal appears to have been carried out entirely by hand sawyers with the exception of portion of Ingeli where in 1891 it was recorded that a saw mill was in course of erection on private land in the vicinity.

According to Colonel Cardew, exploitation of the Zululand forests began at Qudeni, which is situated on the heights between the Tugela and Insuzi rivers. At this centre about 4,000 acres of forest are met with. Cutting was commenced long before annexation in 1897, by sawyers, who apparently obtained permission from the paramount chief. A steam saw mill was started about 1897 by the Qudeni Saw Mills Co. and functioned until 1918 when the machinery and buildings were dismantled. The long and continuous exploitation of these forests has lowered their general height growth and completely altered their character. Colonel Cardew, who described the Qudeni forests as "the finest in Zululand" stated that they resembled the high timber forests of Natal and that they contained an abundance of both upright and outeniqua yellowwoods. Burton who visited them in 1914 described the western

portion as "a black ironwood forest" and made no mention at all of the occurrence of yellowwood in this section. In regard to the eastern portion he said "occasionally large stems of real (upright) yellowwood are met with; as a rule, however, they are either badly shaped or defective as to timber" and "isolated specimens of bastard (Outeniqua) yellowwood were seen." From these extracts it would appear that the yellowwoods which yielded the class of timber most sought after have been practically annihilated and the forest has passed over to black ironwood, wild lemon and other hardwood species.

Portion of Ngoya forest near Port Durnford was exploited by the Ngoya Forest Co. under a ten-year concession granted by the Natal Government towards the end of 1909. A mill established alongside the forest in 1910 functioned until 1916 and then remained idle until the company was wound up in 1924. Figures are not available to show the quantity of wood removed by the Company but as far as can be ascertained the total was somewhere in the neighbourhood of 900,000 cu. ft. of which a good deal consisted of props for the Rand mines. The Ngoya forest is about 7,000 acres in extent and contains a large number of species but the general height does not exceed 50 feet. Outeniqua yellowwood is not plentiful and upright yellowwood is rare.

For two or three years after 1916, the swamp forest on Umsingwenya forest reserve near Port Durnford was exploited by Messrs. Gray Bros. who operated a small saw mill for the conversion of um-Doni *(Syzygium cordata)* into light sleepers. When the supply of wood gave out the mill was moved to near Port Shepstone and later to Eshowe where it is still in operation. It is now owned by Mr. Atkinson who saws mainly *Euc. maculata* timber obtained from Port Durnford plantation.

The Nkandhla forest covers an area of roughly 4,000 acres between the Insuzi and Umhlatuzi rivers. Being somewhat difficult of access it has not received much attention by timber getters and may consequently be regarded as more or less intact. The only working that has taken place appears to have been confined to poles and probably a few large sized trees here and there. Reports agree that the type of forest at Nkandhla is not nearly as good as that at Qudeni.

A good deal further north the Ngomi forest is met with on a range of hills which forms the sources of the White and Black Umfolosi rivers. This forest, about 9,000 acres in extent, is situated in territory which formerly formed part of the Transvaal but was incorporated in Natal after the Anglo-Boer war. Henkel, Conservator of Forests, spent some time at Ngomi in 1919 and submitted an exhaustive report on the forest. From his description its composition is very similar to that of the forests met with in eastern and north-eastern Transvaal. *Podocarpus Henkelii,* which is a characteristic feature of the mist belt forests of East Griqualand and Natal does not occur at Ngomi while Outeniqua yellowwood is sparingly represented. Upright yellowwood is more plentiful than the latter but was never numerous. On evidence obtained from woodcutters, Henkel recorded that, during the long period of exploitation, only two large black stinkwood trees were found. Many other species are represented and include black ironwood, water pear, red stinkwood, *Faurea, Homalium,* red pear, white pear and essenhout. The forest was heavily worked during the period it was under the jurisdiction of the Transvaal Republic. According to the evidence of a man named Rorke, who resided on the reserve, exploitation began in 1876 and continued until

the outbreak of the Anglo-Boer war. An Overseer named Barnard was in charge and collected revenue on behalf of the Government, the tariff being 2s. 6d. per month per saw with an addition charge of 10 shillings for each load of 800 running feet of sawn timber. About 70 to 80 woodcutters were continuously employed and were allowed to cut anywhere and anything they liked. Most of the big trees of utilizable species were felled. To-day the dominant species is water pear (*Syzygium Gerrardii*) but a satisfactory feature is that regeneration of good species is said to be abundant.

Transvaal Conservancy

A considerable area in central and northern Transvaal and in the low lying country between the escarpment of the Drakensberg and Zoutpansberg mountains and the Portuguese border is occupied by a dry open type of forest known as the bush veld. The greater part of the bush veld is privately owned except for the large tract comprising the Kruger National Park and ground set aside for the use of the natives or acquired by the Native Trust.

Real timber forests are met with only at a high altitude along the escarpment which intercepts the moisture laden winds from the sea and, as a result, enjoys a copious rainfall. The total extent of forest in possession of the State is estimated at 30,000 acres. The forest is scattered over a wide area in the form of strips or patches on the lower side of kranses along the berg. Here and there as for instance at Mariepskop near Klasseri, at Woodbush near Tzaneen and on the Zoutpansberg fairly extensive and compact blocks are to be found. The forest is of a sub-tropical type and contains 56 or more tree species which reach timber size. These include Outeniqua and upright yellowwoods, water pear, black ironwood, bitter almond, chestnut, Camdeboo stinkwood, white pear and assegai. Whether yellowwoods were plentiful in the early days is not known definitely but they appear to have been represented only by occasional trees. Outeniqua yellowwood reached a large size. Lane-Poole, on the evidence of a sawyer, recorded that a tree of this species felled at Woodbush yielded as much as 665 cu. ft. of sawn timber. Black stinkwood is sparingly represented here and there but nowhere does it reach the same development as in the Transkei or at Knysna. It is also of interest to note that terblans (*Faurea Macnaughtonii*) occurs at Mariepskop, hard pear (*Strychnos henningsii*) at Woodbush and some large sneezewood at the western end of the Zoutpansberg.

Little is known about the exploitation of the Transvaal forests beyond the broad fact that most of them have been heavily worked and denuded of big trees of those species which yielded the kinds of wood sought after. As in the case of Natal farms were taken up for the timber they contained and abandoned after the forests had been plundered.

According to a report written by Lane-Poole in 1908, exploitation of the Woodbush forests was started as far back as 1840 by farmers who trekked up from other parts of the Transvaal and Orange Free State in search of good building timber and waggon woods. The date appears to have been placed too early as European settlement of the Transvaal did not begin until some years after the great trek from the Cape in 1935-36. The same report also states that in 1870 sawyers established themselves round the forests and opened up a timber trade. Some measure of control over woodcutting became necessary and in 1870

the Volksraad passed an act for the protection of the forests. (Act 8 of) 1870).

The discovery of gold, in the seventies, at various points along the escarpment brought about a considerable influx of miners and others and this in turn gave rise to a strong demand for mining and building timbers. This created a further problem in respect of the forests and for their better protection the Volksraad repealed Act 8 of 1870 and took wider powers under Act 15 of 1880. The latter imposed severe penalties for illegal cutting of trees and contained provision for the appointment of forest officers and the issue of regulations for the management of forests. Regulations were issued under G.N. 5 of 1881 and were followed by departmental instructions for the guidance of forest officers (G.N. 26 of 1881). The regulations prescribed that woodcutters should first take out licences to cut timber. These licences cost 2s. 6d. each and were valid for 30 days in the case of resident sawyers and for 15 days in the case of non-residents. The licencees were then allotted a section of forest and could cut what they liked and as much as they liked. Before timber could be removed from the forest limits, an impost became payable. On payment of the latter, licencees were then given transit passes. The departmental instructions laid down that forests should be divided into sections, that the sections should be properly defined and they should be closed after they had been cleared of mature timber. The term "mature timber" was not defined but was evidently taken to mean trees 9 inches in diameter and over for we find that logs exceeding 8 feet in length and 9 inches in diameter had to be worked on the spot in order to prevent damage by slipping them through the forests to work stations.

On paper a fairly close control was established but as far as can be ascertained only two overseers (Bosch Opzieners) were appointed to administer the law, one at Ngomi (now in Natal) and the other at Woodbush. The latter was appointed about 1890. He left in 1895 and does not appear to have been replaced. These overseers seem to have been remunerated by means of a commission on sales. Consequently the more timber that was sold the better so far as they were concerned. In other words the method tended to defeat the object of the Act and regulations.

The discovery of gold on the Witwatersrand in 1886 and the subsequent development of the mines created an enormous demand for timber. As railway communications with the Rand did not exist at the time the mines were dependent on indigenous woods which had to be transported by ox waggon. There thus arose not only an increased demand for mining and building timbers but also for waggon woods to provide the vast service that became necessary to cope with the transport of machinery and goods to the Rand. Most of the requirements in respect of poles and lagging were presumably obtained from the bush veld in central Transvaal but the mining houses had to go to the real timber forests much further afield to obtain large sized baulks and building timbers. The opening of railway communication with the Rand in 1895 facilitated the importation of Pine timber and rapidly killed the local trade in sawn wood. The use of indigenous timbers for poles and lagging also came to an end when plantations, established for the purpose of supplying the mines, came into bearing.

The mines along the escarpment in eastern and north eastern Transvaal

continued until a much later date to use indigenous woods but now most of them draw their requirements from plantations.

As far back as 1893 the overcutting that was taking place caused the Government some concern for we find in G.N. No. 94 issued during that year that certain forests were closed. Further closures were notified in G.N.'s 508 of 1906 and 463 of 1907.

After the Boer war Hutchins of the Cape forest service was invited to visit the Transvaal and report on forestry matters. On his recommendation a forest service was established with Legat as Chief Forester. At Union the several forest services were amalgamated.

One of the few remaining forests which is still more or less intact is to be found on Mariepskop near Klasseri. The total extent of this forest is about 4,700 acres. Portion has been worked but about 2,000 acres are still in a virgin state. On the higher parts of the mountain the forest consists mainly of *Xymalos, Combretum, Royena* and *Olea laurifolia*. Lower down *Syzygium Gerrardii* becomes the predominating species with a fair amount of *Xymalos* and *Cryptocarya*. Still lower *Protorhus longifolia* becomes the principal species. Parts of the forest contain a light sprinkling of Outeniqua yellowwood, chestnut, assegai, white pear, vlier and other species. The crop of timber trees is not heavy, the volume of merchantable wood averaging only about 2,000 cu. ft. per acre. In 1925 tenders were invited for the purchase of 500,000 cu. ft. of timber from this forest but for various reasons the wood was not disposed of.

Conclusion

From this review it will be seen that, of the 281,000 acres of first class forest, about 77 per cent. of the area has been overworked, of which roughly 28 per cent. has been reduced to Kreupelbos.

Much of the overworking took place before a forest service came into being. The South African forest service, as in other parts of the world, arose out of the damage and reckless waste which took place in the forests and which forced the Government to take action. In the early days wood could not easily be obtained from overseas and was naturally obtained from the indigenous forests nearest at hand. There thus arose a class whose main occupation consisted of woodcutting. These woodcutters were subject to little or no control and as a result depleted the more easily accessible forests of every serviceable tree which would yield the kind of wood required. The requirements consisted mainly of yellowwood for building purposes, various kinds of woods for waggon and cart building, fencing poles and furniture woods. The establishment of a forest service brought to an end the enormous amount of damage and waste which took place and steps were taken to ensure that only part of the crop of mature and overmature trees was felled, the remainder being left for seed bearers and conservation of the forests. What the service failed to accomplish was the regulation of the annual cut on the basis of a sustained yield. This failure was due to the clamour of woodcutters backed by political influence for more and more wood which could not be resisted. As we have seen the result has been that most of the real timber forests have been overworked and a very long time must elapse before they can again yield timber in appreciable quantities. Much as the overcutting is to be regretted, it should be borne in mind that the timber yielded by the forests, although small in quantity,

played an important role in the development of South Africa by supplying building material and waggon woods and in meeting the requirements of the mines when other sources of supply were not available.

Similarly the destruction of forests set aside for the use of natives cannot be wondered at. Wood for hut building, fuel and cattle kraals was and still is a vital necessity and until supplies are obtainable from other sources these people must perforce make what use they can of the forests at their disposal. The position was met in the Transkei and to a small extent in Kaffraria and Natal by establishing wattle plantations which yield the class of wood required. This policy coupled with the long range view of providing saw timber for better class buildings is being extended but until such plantations come into bearing the remnants of location forests cannot very well be closed to further cutting. In many cases the closure of these forests is a matter of urgency to protect steep hillsides against soil erosion and to conserve the water supplies.

One of the problems to be faced is the rehabilitation of forests or parts of forests which were wrecked in the early days and which have not yet recovered from the maltreatment to which they were subjected.

There is no doubt that unless the process of recovery can be accelerated by artificial means those forests will not again become productive, as far as timber is concerned, for a century or more. On the other hand it is difficult, financially, to justify an expenditure of more than a few shillings per acre on cultural operations. Data collected at Knysna show that in forests which have been exploited but have received no cultural treatment common yellowwood, stinkwood and real yellowwood take 156, 196 and 219 years respectively to reach a diameter of 19 inches at breast height. We also know from stock takings which have been carried out that, with the exception of a few forests in East Griqualand, unexploited forest rarely contained more than 3,000 cu. ft. of marketable timber per acre. If, for the sake of argument, it is assumed that cultural operations will reduce the rotation to a common level of 140 years and at the same time raise the yield of marketable timber to 4,000 cu. ft. per acre, a simple calculation will show that, at 3½ per cent. compound interest, an initial expenditure of only £1 per acre will represent a production cost of nearly 7½d. per cu. ft. As the present sale value of indigenous timbers averages only about 7d. per cu. ft. standing and as cultural operations are likely to cost a good deal more than £1 per acre it is obvious that, standing alone, operations designed to improve the condition of these forests are financially unsound. The matter should however, not be looked at entirely from this point of view. Consideration should be given to the fact that the indigenous forests have yielded far more in revenue than has been expended on them. It may therefore well be argued that part of the surplus should be applied to the rehabilitation of those which have been practically reduced to kreupelbos. This applies particularly to parts of native areas where portion if not more than the whole of the initial cost can be recouped from the sale of wood which may be felled in forests where cultural operations are undertaken. Some experimental work has already been carried out but a good deal more is necessary before it will be possible to decide upon the lines of treatment best suited to each type of forest or to different site factors.

In some forests where species of little economic value have practically taken possession of the soil, these species and decayed trees have been felled and exotics, consisting mainly of conifers, have been established

in the clearances. The latter have been introduced not with the object of displacing the natural forests but to serve as nurse trees and at the same time yield a return in a relatively short time. In others where a dense growth of timber species has taken place, thinning has been resorted to in order to relieve the competition for growing space. The regrowth, in many places, reaches a height of about 30 feet and then makes little further progress. This stunted condition may be the result of mutual suppression, deterioration of site factors or complete destruction of the high overhead cover which most timber species appear to need until they reach their principal height growth. Whether thinning will stimulate height growth is doubtful but at any rate the operation should materially assist diameter increment.

In forests which have been exploited but still contain a fair amount of timber, any further exploitation will have to be carried out with great care otherwise there is a danger of bringing about conditions such as those indicated above. The marking of trees to be felled will, it is thought, have to be confined mainly to broad-leaved species in the lower storey and without an eye on the local market. If culling for timber which happens to find a ready market is persisted in, there is no doubt that the forests will ultimately degenerate to species of little economic value. The difficulty in regard to the disposal of woods not saleable locally will probably be overcome by investigations which are being carried out by the Forest Products Institute with a view to determining the uses to which such woods could be put and their introduction on the market in a manufactured form.

Of forests more or less intact, we still have about 14,750 acres. These comprise parts of the Schwarzwald and Upper Wolf River in the eastern conservancy, certain forests or parts of forests at Manina, Tonti and Mgano in the Transkei, the Impetyne, Ili, Xalengeni and Xumeni in Natal, Nkandhla in Zululand and portion of the forest on Mariepskop in Eastern Transvaal. The writer's personal view in regard to these forests is that, although they contain a fairly large quantity of mature and overmature timber, they should not be exploited but strictly preserved as places of interest not only for forest officers but all lovers of nature. Once tampered with they can never be restored to their original condition. Should exploitation become necessary felling should be permitted only under rigid prescriptions laid down in working plans which should, as far as possible, aim at the maintenance of the present character of the forests. Probably an annual cut of not more than 200 to 300 cu. ft. per acre once in every 40 years is all that would be permissible. This then is the story of the indigenous forests as far as the writer has been able to piece it together. There is, however, a brighter side to the picture. Plantations established by the State in various parts of the country are now coming into bearing and are already yielding much more wood per annum than was ever derived from the forests. Seventeen privately owned and four state mills are now operating on softwoods derived from these plantations and consume over 6 million cu. ft. a year. The quantity is steadily increasing and 25 to 30 years hence is expected to reach about 60 to 70 million cu. ft. per annum. In addition to softwoods the plantations annually yield several million cubic feet of hardwoods. These hardwoods consist mainly of eucalypts from which high class strip flooring and floor blocks can be manufactured. The erection of a hardwood mill is now under consideration. The object of this mill is to deal not only

with hardwoods from plantations but also indigenous timbers which are not readily saleable in the local markets.

Mention should also be made of the fact that roughly 500,000 acres of wattles and 300,000 acres of eucalypts have been established by private enterprise for commercial purposes. It may safely be said that plantation grown wood has very considerably lessened the drain on the natural timber resources of the country and prevented the complete annihilation of the forests.

THE VALUE OF AN IMMATURE PLANTATION.

By A. J. O'CONNOR

THE following is an account (quite unreliable from the viewpoint of Court procedure) of the proceedings in a purely imaginary case involving a claim for compensation for loss sustained in the destruction of a 20 acre plantation by fire caused by the carelessness of the defendant. The plantation in question consisted of eucalypts grown for mining poles, and was destroyed when it was four years old, i.e. before the trees had any sale value. (Incidentally, the basic data, i.e. the rotation, the final value, and initial outlay, may be accepted as authentic if circumstances are particularly favourable.)

The first witness called on behalf of the claimant was a young professional forester. In spite of (perhaps because of) his youth and inexperience he felt confident that the evidence he was about to give on the value of the plantation at the time of its destruction could not be seriously questioned. He thought himself thoroughly entrenched by his text books in giving the expectation value. Cross examination would no doubt be centred on the rotation (8 years) he had adopted, on the final value of the crop (£48 10s. 0d. per acre) and the rate of interest (5 per cent.). He had, however, gone to a great deal of trouble in arming himself with solid facts in support of the rotation, the final yield of similar plantations and the trend in values of mining timber. As for the rate of interest, he saw no danger there either, because 5 per cent. was a fair compromise between the rates yielded by speculative and gilt edged investment. Full of confidence the witness stepped into the witness box and gave his estimate of the value of the plantation, at the time of its destruction, as £39 9s. per acre. He explained at the same time how that figure was arrived at.

Lawyer for defendent : You state that your estimate is arrived at by adopting a rotation of 8 years, a final value of £48 10s. 0d. per acre, and by discounting the latter figure at 5 per cent. compound interest down for a period of 4 years.

Witness : Yes, that is a recognised method of valuing immature plantations as I can prove. I can prove also that a rotation of 8 years and a final value of £48 10s. 0d. per acre are valid assumptions.

Lawyer : Save yourself the trouble. I accept your assumption that the trees could have been sold for £48 10s. 0d. per acre had they survived until the eighth year. *The witness sighs with relief.* What I am leading up to, however, is this: You say, and I agree, that a sum of £48.5 discounted at 5 per cent. for 4 years amounts to £39 9s. In other words you maintain that if the claimant could get an amount equal to £39.9 per acre for every acre destroyed he could invest it at 5 per cent. and after 4 years realise £48.5 per acre.

Witness, after some hesitation : You can put it that way if you like.

Lawyer : But the statement just made does not in any way prove that the value of the plantation was £39.9 per acre when it was destroyed. It is merely the figure the claimant hopes to receive.

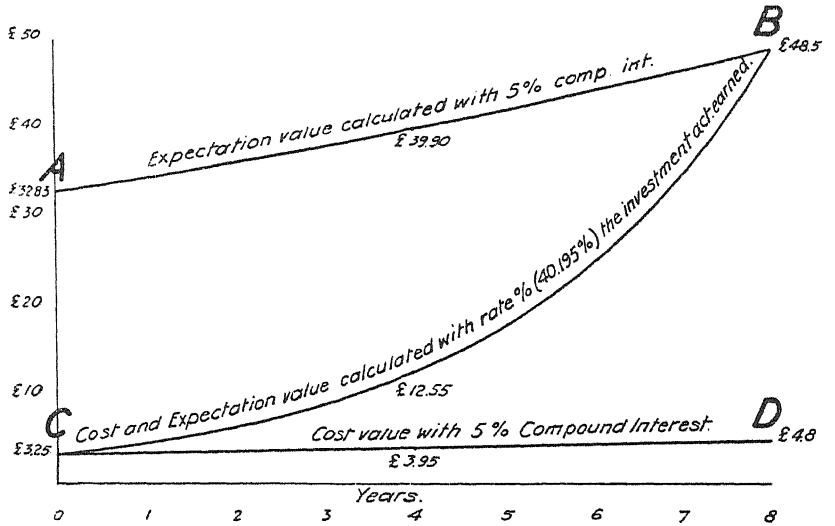
Witness : Nevertheless, from the calculations I have detailed, it is a fair compensation for the loss sustained by him.

Lawyer : That is for the Court to decide. Tell me, what do you think it cost the claimant to establish the plantation?

Witness, after some figuring : About £3.25 per acre.

Lawyer : I accept the estimate. Now let us go back a moment. You arrive at £39.9 per acre by discounting £48.5 down for a period of 4 years. Is there any logical reason, supposing the plantation had been destroyed when it was three instead of four years old, why the sum of £48.5 per acre should not be discounted down for a period of 5 years?

Witness, doubtfully : None as far as I can see.



Expectation and cost value of an immature plantation at different rates of interest.

Lawyer : Then there can be no logical reason against discounting the final value for a period of 6, 7 or even 8 years as circumstances may demand. In other words we can arrive at the value of the plantation at any stage in its development, as is shown by the line AB on the diagram I have here. This line indicates that, according to your calculations the value of the plantation at 0 years was £32.83 per acre. You therefore maintain that if the plantation had been destroyed by some act of my client immediately after it was planted, he could be fairly mulcted in the sum of £32.83 per acre when the claimant's outlay was only £3.25 per acre.

Witness, now getting flurried : Well you see in the case of very young plantations, the loss would be assessed on the cost value, i.e. the cost of establishment plus compound interest for the time that elapsed after the initial outlay.

Lawyer : I see. In assessing the damage on cost value, I presume you would also allow 5 per cent., and would apply this method if the plantation was quite young, say one or two years old.

Witness : Yes.

Lawyer : Then there cannot be any logical reason why the same calculation should not be applied to a plantation 3 and even 4 years old. Now £3.25 with compound interest at 5 per cent. amounts in 4 years to no more than £3.95 per acre. How can you maintain, as you do, that my client should pay compensation at the rate of £39.9 per acre?

Witness, now quite unhappy : Well you see it depends on the way you look at the matter . . . .

Lawyer : You mean the way *you* look at it. I am sorry, but I must protect my client against claims based on arbitrary viewpoints. Thank you.

A puzzled and crest-fallen forester steps down from the witness box.

Your Worship, I submit that the assessment of the damage amounting to £39.9 per acre based on the so-called expectation value, is outrageous and has nothing whatsoever to support it. On the other hand assessment on the cost value amounting to £3.95 per acre is eminently fair to both parties. If judgment is given in the amount of £3.95 per acre the claimant would not only recover his original outlay, but would also be paid a good rate of interest thereon. I submit he cannot reasonably expect more and I confidently leave the matter in your hands.

Lawyer for the Claimant : Your Worship, I am, on the other hand, quite confident that you will not allow yourself to be blinded to the admitted facts of the case which clearly indicate that my client has suffered far greater loss than that assessed on the basis of cost value. Let us examine the latter and use the same type of argument with which my learned friend tried to confound my witness. The assessment of £3.95 per acre is arrived at by taking the initial outlay of £3.25 per acre and adding thereto compound interest at 5 per cent. for a period of four years. Now supposing that the plantation had been destroyed when it was five years old instead of four. If cost value were the correct basis for estimating the damage, would there be any logical reason against an assessment arrived at by adding interest for five years to the initial outlay? Of course there would be no such reason. That being so, there would be no logical reason against assessing the value of the plantation on the same basis in the sixth, seventh or eighth year. The line CD which I have shown on the chart shows the rise in value of an investment of £3.25 with 5 per cent. compound interest. In the eighth year the value is £4.8. According to the arguments he used my learned friend maintains that my client could not reasonably have expected a return of more than £4.8 per acre from his plantation in the eighth year. At the same time he admits that the trees had they survived until the eighth year, could have been sold for £48.5 per acre. Such inconsistency speaks for itself. I submit that the accepted final value of £48.5 per acre is the only one on which the assessment of damage could be based and that this value discounted down to the fourth year when the plantation was destroyed actually represents the loss suffered by my client and that he should be compensated accordingly.

His Worship : The logical arguments which have been advanced for and against the cost value and expectation value methods of assessment leave one completely in the dark as to the true value of the plantation at the time it was destroyed. Since the two methods give results so widely different, it is logical to assume that there must be a fallacy

somewhere. Being a disinterested party I can perhaps point to the fallacy but it would be better if we get the opinion of a business man in the matter. I see Mr. A in Court. We all know him to be a competent business man whose judgment can be trusted. He has been making some sort of calculations while sitting there and has listened to the arguments with some amusement showing on his face. Mr. A, would you mind?

Mr. A obligingly steps into the witness box and after the usual preliminaries submits himself to question.

Mr. A, you have listened to the arguments advanced in support of adopting the expectation value and cost value methods of assessment. Which of these two methods do you consider correct?

Mr. A : They are both correct.

His Worship : But how, then, do you account for the widely different assessment of the value of the plantation in the fourth year?

Mr. A : The trouble lies in the rate of interest that has been adopted in the calculations.

His Worship : But surely 5 per cent. seems fair enough, being, as explained, intermediate between the rates expected from speculative and gilt edged investments.

Mr. A : It is a perfectly appropriate rate considered in connection with the usual run of investments, but it has no sort of connection with the case under consideration. I do not see why the parties concerned adopted it in their calculations in face of the accepted facts.

His Worship : Please explain.

Mr. A : Well, it is accepted that the claimant spent £3.25 per acre in establishing his plantation. It is also accepted that the trees would have reached a value of £48.5 per acre in the eighth year. Now an investment of £3.25 which increases to £48.5 per acre in eight years earns, not 5 per cent., but 40.195 per cent. compound interest. I show on the chart by means of the line CB the increased value, year by year, of a sum of £3.25 invested at 40.195 per cent. compound interest. You will see that in the fourth year the value is £12.55

His Worship : Then the cost value of the plantation in the fourth year when it was destroyed was £12.55 per acre. What about the expectation value?

Mr. A : If you discount the anticipated final value of the plantation down for a period of four years at 40.195 per cent. compound interest, the result is also £12.55. In other words the cost and expectation values are identical, and any calculations which make them different must be fallacious somewhere.

His Worship: I see. We have heard a lot of logical arguments, but only now have been able to arrive at a logical conclusion. You maintain then, Mr. A, that £12.55 per acre represents the maximum value that could be attached to the plantation at the time it was destroyed?

Mr. A : Yes, provided that it at no time had or could have reached a sale value above the values marked by the line CB on the chart, or by an extension of it beyond the eighth year.

His Worship : I believe the final value of £48.5 in the eighth year is accepted as valid by both parties. Thank you Mr. A, we now know where we stand.

Mr. A steps down.

We have had presented to us two methods of arriving at the

value of the plantation at the time of its destruction, namely that based on the expectation value and that based on the cost value. Both these methods seem to be sound in principle but we have seen that they lead to absurdly different results when the current rate of interest is applied in the calculations. Now I am satisfied that the expert witness, in using 5 per cent. as the rate of interest for arriving at his valuation, did so in all good faith. The use of the current rate is evidently sanctioned by his text books. One asks oneself, therefore, why the text book procedure has been accepted without being questioned in the same way as has been done to-day. The answer, it seems to me, is to be found in the fact that text book calculations are normally applied to cases where the rotation is very much longer, and the final value in relation to the initial outlay very much less than in the case we have been considering. If the rate of interest is of the same order as the current rate, there would be no great absurdity apparent in using the latter for arriving at the value of immature plantations, especially if the rotation is a long one. The longer the rotation and the younger the age at which valution has to be made, the more likely will question be focussed on the validity of an estimate of the final value, rather than the rate of interest. If the value is sought at a time approaching the end of the rotation, the fallacy of using the current rate would also be obscured. The issue would further be clouded by the recurrent expenditure and revenue during the rotation which, presumably, must also be taken into account. In short it requires a clear cut case like the one we have been considering, one involving a very short rotation and a very high relative yield, to bring out the fallacy inherent in the use of the current rate of interest. In representing these views I am probably laying myself open to attack by experts in forest finance. Nevertheless I am sure that a plantation at any particular stage cannot have two different values. I therefore accept Mr. A's interpretation of the position and judgment is accordingly given for the claimant in the sum of £251, being the value of 20 acres destroyed at £12.55 per acre.

AN APPROACH TO THE STUDY OF RAINFALL INTERCEPTION BY FOREST CANOPIES

By C. L. WICHT

(Forest Research Officer, Jonkershoek.)

IN A forest only a part of the rainfall reaches the ground. The rest is intercepted by leaves, twigs, branches and stems of trees and is, for the most part, evaporated. A small, relatively insignificant, quantity of moisture may be absorbed directly by the leaves. Rain penetrates to the forest floor by falling directly through openings in the canopy, by dripping from the crowns and by running down the tree stems. If the total quantity of water penetrating in these ways is gauged and subtracted from the quantity gauged outside the forest, the remainder will be an estimate of the total rainfall interception. The study of mist condensation on vegetation is closely related to the study of rainfall interception. On misty days moisture condenses on the leaves and twigs of trees, and precipitation in the form of drip and stem run-off may then be recorded in the forest, although no rainfall has occurred in the open.

The forest hydrological investigations, which are being conducted at the Jonkershoek Research Station, will include detailed empirical studies of rainfall interception and mist condensation in forests. The interception by plantations of the most important economic timber species at Jonkershoek—*Pinus radiata* D. Don. (syn. *P. insignis* Dougl.)—is to be investigated mainly. A preliminary experiment has, however, been carried out in a conveniently situated stand of *Populus canescens* Smith, in order to develop and test a suitable technique, which could be applied later in pine plantations. The object of this paper is to give the results of the investigation in the poplar stand, and to provide a historical discussion of previous investigations of this problem. The paper is to be the first of a series giving details of studies of rainfall interception at Jonkershoek.

The author gratefully acknowledges the very valuable assistance and advice received from Professor J. T. Morrison, of Stellenbosch, who has been responsible for the statistical analysis of the measurements of direct penetration and drip.

Historical Review

Many experiments to determine the percentage of rainfall intercepted by stands of various species of trees have been conducted. The first were organised by Krutzsch of Tharandt, Saxony, Germany, in 1863 (3,28). He was followed by Ebermayer and Ney in Germany in 1864 and 1893, Mathieu in France in 1866 and Fankhauser in Switzerland in 1869. Towards the end of the 19th century interception measurements were made in connection with State forest meteorological investigations in Germany, Austria and Switzerland. The results yielded by all these early studies were unreliable. Hoppe (3,21) pointed out that the positions

of the raingauges in the forests had not been considered sufficiently. This he showed could cause differences in the penetration of up to 50 per cent. Measurements by Bühler in 1892 indicated that variations in the character of the stand due to age, could cause considerable differences in the amount of interception. The early investigations also failed to take into account one or more of the following factors, which affect the interception: density of stand; intensity, amount, duration and local distribution of rainfall; and wind. In most cases the water reaching the ground by running down the stems of trees was not measured (4,21), but observations of the run-off from tree stems were published by Riegler in 1879 (19). Some of the early experiments were conducted over short periods, and these inadequate samples were used to estimate the percentage of annual rainfall interception. In all cases too few gauges were established inside the forest. The data yielded by these studies have been summarised and discussed by Zon (28) and by Toumey and Korstian (24), but they must be accepted with reserve when the hydrological influences of forests are being considered.

In 1919, Horton (10) published an account of observations made by him in the United States of America. He gauged the stem run-off very carefully and studied the effects of individual showers varying in intensity and duration. He, however, took samples of the water passing through the crowns of *single* trees of various species, and his data cannot be used satisfactorily to estimate the interception of stands of trees. Horton used large raingauges—inceptometers—with funnels seventeen inches across. One of these was used for each tree and it was placed "under complete leaf cover of average thickness." Random samples were, therefore, not taken. Instead of a single, large sample of penetration, it would have been better to have collected a number of smaller samples by using several standard five or eight inch raingauges placed at random under the trees. These would have reflected the effects of variations in the canopy, so that the interception of the forest as a whole could have been more accurately estimated.

One problem in planning this kind of research is to determine how many such gauges should be used under forest canopy, in order to obtain a reliable estimate. Wood (27) in 1937 used four 8-inch gauges in an oak-pine forest, but from his observations he concluded that about eighteen gauges should have been used.

Other recent estimations of rainfall interception have not advanced the investigation of the problem much further. Burger (4,5) in Switzerland has carried on the work of Bühler, but he did not measure stem run-off. Mitchell (15), Holch (9), Simson (22) and Maule (14) in the United States and Beall (1) in Canada have measured the interception in various localities and in various forest types. Ovsyannikoff—quoted by Brooks (2)—has given figures from Japan, and Phillips (18) has published data collected in semi-tropical, evergreen forest at Knysna, South Africa. These workers did not improve on the technique used by earlier scientists.

A novel method of studying rainfall interception is described by H. F. Blaney and C. A. Taylor (29). In their experiments felled citrus trees were used. These were sprinkled with water, weighed and re-weighed. In this way the amounts of water held by the crowns of trees after wetting, after drip, after shaking, etc., could be determined. Large forest trees cannot be treated in this manner, but the method could probably be used successfully to study the interception by shrubs and small trees.

Remarkably high quantities of moisture, derived from mist condensation on the shrubby vegetation of the Cape, were gauged on Table Mountain by Marloth (12,13) from 1902 to 1905. By placing a number of reeds over the funnel of a standard five-inch raingauge, he found that the amount of water caught in misty weather was considerably increased over that caught by a similar gauge without reeds. Comparable work has been done by de Forest (7) in the United States and Phillips (16, 17, 18) at Knysna, South Africa. Drip in the forest as a result of mist condensation when no rain is recorded in the open, was first studied by Linke (11) in Germany in 1921. Rubner (20, 21) of Tharandt, Germany, has investigated the problem thoroughly. He established well equipped observation stations inside and outside the forest and used a specially developed condensation-gauge to obtain a relative measure of water deposited in this way. At Jonkershoek the drip and stem run-off, which occur when mists condense in the crowns of trees, will be observed only if it can be gauged with the apparatus placed in the forest to measure rainfall interception. The moisture condensed and again evaporated in the tree crowns will not be investigated at present. For such a study special instruments like those used by Rubner would be required.

In spite of the many rainfall interception experiments which have been conducted in the past seventy-eight years, further more complete and carefully planned research is needed. Such intensive experiments with improved technique are apparently now being carried out in the United States (32), and preliminary results have been published. Full details of these investigations are not yet available.

Interception Experiment in Stand of Poplars at Jonkershoek

The rain intercepted by a grey poplar stand was observed for one year, from September, 1938, to August, 1939. The experiment consisted of estimating the total penetration derived from rain and mist condensation and comparing it with rainfall recorded in the open.

Description of Stand and Site.

The poplar stand originated when the trees invaded the indigenous shrub veld. The pioneer trees are no longer standing, but some rotting stumps remain. The present stand has developed naturally from root suckers and coppice shoots. Some trees are probably about forty years old, but smaller trees growing up into the canopy are younger. The older trees are branchy, indicating that they developed in nearly open veld. Younger trees have suffered from competition. They have restricted crowns and are inclined to "whip." The stand is poor and has received no sylvicultural treatment, except a cleaning in 1937 when fifty per cent. of the stems were removed. These were all small and suppressed. The remaining trees are growing slowly. Particulars of two enumerations of the stand at the beginning and end of the experimental period, are given in Table I. The trees were bare of all leaves for the winter months June, July, August and September. Leaves developed in October and the trees were in full leaf from November to March. In April and May the leaves were falling. These changes in the canopy caused striking variations in the amount of water intercepted.

Rainfall interception was not easy to estimate in this deciduous, uneven-aged and badly grown stand. It is expected that the investigations,

TABLE I.

PARTICULARS OF POPLAR STAND.

Date of enumeration	Age	D.B.H. ins.		Mean height ft.	No. of stems	Basa area per acre
		Range	Mean			
Oct., 1938	Uneven	2.5—16	8.21	65.0	260	126.7
Oct., 1939	Uneven	2.5—16.5	8.57	66.5	260	132.8

which are later to be concentrated in uniform pine plantations, will be simpler.

The site of the experiment appeared to be very uniform. The poplar stand is situated on a level river terrace near the bottom of the Jonkershoek valley. This valley lies from north-west to south-east and is deep and narrow. In summer the prevailing south-east wind brings no precipitation to the experimental area. In winter the rain-bringing wind blows up the valley on to the stand from the north-west. The edge of the stand runs south-west to north-east, at right angles to the rain winds. An open cultivated field adjoins the stand to the north-west (see Fig.I). The experimental area would most probably receive a uniform rainfall if the poplars were entirely removed.

Description of Experiment.

The general lay-out of the experiment is shown in Fig. I.

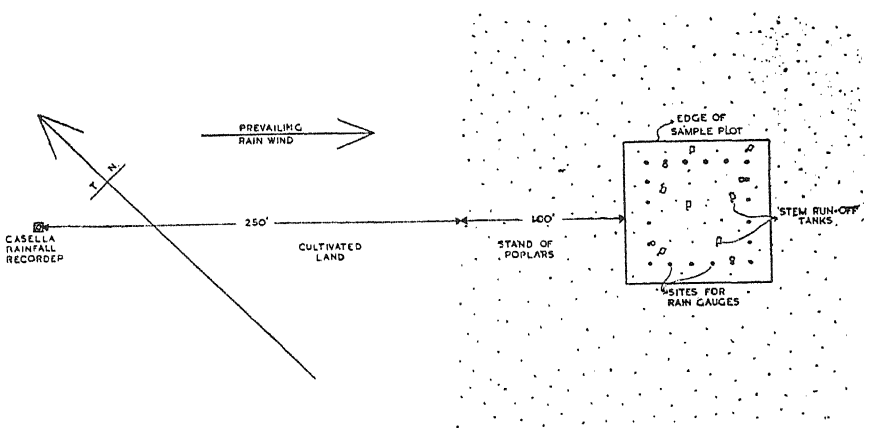


FIG. 1.—Rainfall interception experiment in stand of grey poplars in Jonkershoek.

Measurement of rainfall in the open.

Rain received in the open was gauged by an eight-inch Casella Siphon Rainfall Recorder with daily charts. The amount, duration and intensity of all showers were registered. The gauge stood about 250 feet to the north-west of the edge of the wood, that is, in the only direction from which rain-bringing winds blew during the period of investigation. The

rim of the funnel was mounted four feet above the soil and the surrounding herbaceous vegetation was kept low by slashing.

The rainfall received during the year of investigation was 35.09 inches, which is about five inches lower than the average recorded in this vicinity for the period 1925 to 1938 (25). The rainfall is, however, high enough for the cultivation of grey poplars in this region, and the experimental results should be valid even though the year was relatively dry. The rain was normally distributed. No exceptionally intense storms or long droughts occurred.

Measurement of direct penetration and drip.

Inside the wood the direct penetration and drip were measured in four standard five-inch raingauges of the Snowden type, which were read daily. These gauges were not established permanently at four sites in the usual way. Twenty gauging sites were fixed, and the gauges were so erected, that they could easily be moved from one site to the next. In this manner the penetration under twenty variations in the canopy could be sampled although only four gauges were used. The gauging sites were situated ten feet apart on the sides of a fifty foot square marked off inside a tenth acre plot. This plot was laid out about 100 feet from the edge of the wood. The gauges were mounted on posts to which they were attached in such a way, that they could easily be removed or replaced (see Figs. 3 and 4). The rims of the funnels were four feet above the ground. The four gauges were placed on the posts numbered 1, 6, 11 and 16 on the first day of the experiment. They were moved each day—whether rain had fallen or not—and were on the posts 2, 7, 12 and 17 on the second day, on 3, 8, 13 and 18 on the third day, etc.

The means of the readings of the four gauges gave estimates of the direct rainfall penetration and drip on the area not occupied by the bases of the tree stems. No water could reach the area occupied by the tree bases, and the water falling on the trees and reaching the ground as stem run-off was measured independently. If the mean of the four gauges were used, without correction, the estimate of direct penetration and drip would, therefore, be too high. This mean should be multiplied by the following correction factor:

$$\frac{(43{,}560 - b)}{43{,}560}$$

where b is the basal area in square feet at ground level, of all trees on one acre. For the experimental poplar stand, however, the correction was only 0.3 per cent., and because this error is too small to affect the experimental result seriously, the uncorrected mean readings were used in all estimations.

The estimation of direct penetration and drip was replicated four times when a reading was taken because four gauges were used. This was repeated as many times as there were rainy days. The estimations were also repeated under five sets of four variations of the canopy, because the four gauges were circulated on twenty gauging sites. These points are important in analysing the readings, and they will be stressed again in a later section of this paper.

Measurement of stem run-off.

The stem run-off was measured from seven sample trees selected

over the diameter range of trees on the tenth acre plot. These are marked by small rectangles in Fig. 1. The run-off was caught and measured as follows. The bark of the trees was first smoothed in a spiral round the stem. A two-and-a-half inch wide strip of lead sheeting was then formed into a small gutter. This was attached to the tree by a one inch nail at the upper end and fitted as closely as possible round the stem on the smoothed spiral. The guttering was again fixed by a second one inch nail at the lower end. The edge of the lead guttering against the bole of the tree was then forced into all irregularities with the end of a screw-driver and the join was made watertight with an asbestos-bitumen cement. The water running down the tree stem was caught in the guttering, ran round the spiral and discharged into a tank placed at the lower end (see Fig. 4 and also Fig. 8 facing p. 76 of No. 3 of this Journal published in October, 1939). This method resembles that used by Horton (10), and was very satisfactory. The cement and the lead seemed to expand enough so that the guttering did not become loose because of the growth of the trees. Asbestos-bitumen cement was smeared over minor leaks once or twice during the year, and the guttering was kept free from falling leaves, etc. No other attention was needed.

The run-off from the seven sample trees was measured to the nearest tenth of a gallon. These readings were used to estimate, in inches of rainfall, the amount of precipitation reaching the ground in this way.

To convert the stem run-off from sample trees to the equivalent in inches of rain, the strong correlation which exists between amount of run-off and the basal area of the tree at breast height was used. In Fig. 2 the total run-off from each sample tree for the year has been

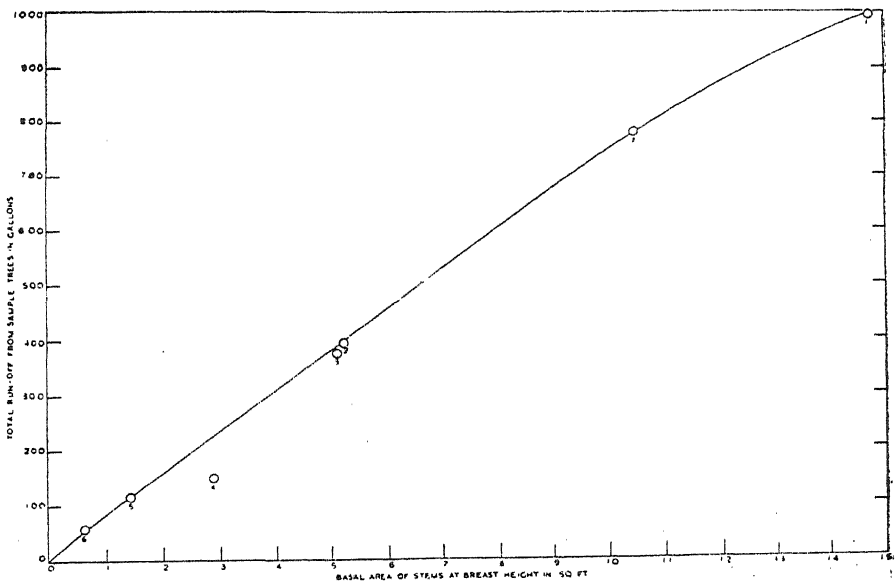


FIG. 2.—Relation between stem run-off for year and basal area of trees.

plotted over its basal area. Six of the seven points lie very close to a smooth curve. Inspection in the field showed that tree No. 4 was abnormal in that it had a bad crook just above the guttering and the

stem was covered with epicormic branches. One method of converting the readings resembles Kopetzky's and Gehrhardt's Volume Line Methods (23, p. 134) of estimating the timber volume of stands of trees with the help of sample trees. In this method the trees on the tenth acre are tallied into breast height diameter classes. Taking the basal area for each class the equivalent amount of run-off is then read from a graph similar to Fig. 2. The number of trees in each class is multiplied by the corresponding volume run-off, and the products for all classes represented are added, to give the total stem run-off on one tenth acre in gallons. This figure is divided by 2,262.3 to give the equivalent reading in inches of rainfall. The method is reliable, but as a graph has to be drawn for each estimate it is laborious. It is also difficult to draw smooth curves through the points when the run-off is low, for example, for daily amounts, because with small samples the variation in the amount of run-off from individual trees is greater. This increase in variation is probably due to the greater effect of casual variations in wind, etc., on the readings.

A simpler, approximate method was, therefore, devised, which gave results that were sufficiently accurate for the purpose of the investigation (26). This method relies on the fact that the stem run-off over basal area curve is very nearly a straight line passing through the origin. By using the ratio of basal area of sample trees to basal area of trees in a stand of one acre, the total stem run-off per acre could thus be calculated by simple proportion and reduced to inches of rainfall. The following formula was used:

$$R = \frac{B \times v}{b \times 22{,}623}$$

where R = inches of rainfall represented by the stem run-off; v = total stem run-off from sample trees in gallons; b = total basal area of sample trees in square feet; and B = total basal area of the stand of one acre in square feet.

An estimation of total rainfall penetration expressed in inches was obtained by adding the mean of the four raingauges in the forest, that is, the direct penetration and drip, to the estimation of stem run-off. This sum was deducted from the amount of rainfall recorded in the open to estimate the rainfall intercepted by the forest canopy.

Interpretation of Observations

The method of investigating rainfall in terception by establishing paired stations inside and outside the forest can be criticised. These criticisms, which apply also to all previous investigations of this type, must be considered before the data yielded by the poplar bush experiment can be analysed.

In this method it is assumed that the rain received above the canopy is not significantly different from that gauged in the adjacent open field. The stand of trees may, however, change the local distribution of rainfall, so that the forest canopy over the gauging sites will receive more or less rain than the gauge in the open. The experiment would be improved if, instead of gauging the precipitation in the open, it could be gauged immediately above the canopy. Davis (6) has designed a practical installation to raise gauges above the tree crowns, and it is hoped to adopt this improvement in future experiments at Jonkershoek.



FIG. 3.—Rain gauge attached to post under poplars. Other posts to which gauge was moved appear in the background.



FIG. 4.—Stem run-off tank and guttering, rain gauge and rain gauge posts under poplars.

A second, probably serious, source of error in this investigation is the effect of wind on the accuracy with which precipitation is gauged (25, 28). The gauge in the open is more exposed to wind and, therefore, may give a considerable under-estimate of downpour. This error, which may be as high as 20 per cent., is caused by eddies over the funnel of the rain-gauge. It will cause an under-estimate of the interception. Methods of screening gauges from the wind are now being investigated at Jonkershoek.

Observations made with different types of rain-gauges are not strictly comparable. In the present experiment readings taken with a single eight inch Casella Rainfall Recorder were compared with the mean of readings taken with four five inch gauges. The inaccuracies introduced in this way are probably very small, but if small amounts of precipitation are compared, they may nevertheless be significant. In future experiments the number of gauges used to measure direct penetration and drip inside the forest, will be duplicated in the open. This should also be done above the canopy, so that the variations in rainfall distribution in the open and above the canopy, will be sampled as efficiently as the variations in penetration in the bush. If it can be proved that so many gauges are unnecessary, some of them may be removed later.

Estimations of the total amount of interception, derived from experiments of this type, can be only approximately correct, because of these shortcomings in the experimental method. The rainfall penetration is determined independently of the rainfall gauged in the open, however, and the accuracy with which it is estimated depends only on how satisfactory the gauging technique and methods of sampling are. An analysis of the penetration data yielded by the experiment, should, therefore, give reliable information about the nature of penetration, the accuracy of the technique of measurement, and the errors of sampling.

Accuracy of estimating rainfall penetration.

The measurements of direct penetration and drip at twenty points lying ten feet apart along the four sides of a square of side fifty feet in the poplar bush (see Fig. 1), enable us to come to reasonably trustworthy conclusions regarding two important questions. The first of these is the question of the fractional extent to which the mean reading of a gauge is likely to be altered by change of position, involving, of course, change of canopy and of branch and trunk sheltering, apart from other more casual changes such as direction and speed of wind, intensity and unevenness of showers, change in canopy due to fall of leaves, etc. The second question, of still greater practical importance, is that of the total number of gauges which must be used to reduce the standard error of the measured mean amount of direct penetration and drip of a fairly homogeneous forest area to a given percentage of the mean, as, for instance, five per cent.

In order to discuss the bearing of the year's data on these questions, it will be helpful if we call the four sides of the square A, B, C, D and the five positions of the A raingauge on five successive days A_1, A_2, A_3, A_4, A_5, and similarly for the other sides. Let the daily replicated readings of the four gauges in the positions A_1, B_1, C_1, D_1 be called α_1, β_1, γ_1, δ_1 and their mean g_1, which may be taken as the amount of direct penetration and drip for the square plot on the day. This particular group of positions G_1 was occupied on seventy-three days of the year, but penetration was recorded on only twenty-five days. The means of the

twenty-five readings will be written $\overline{a_1}$, $\overline{\beta_1}$, $\overline{\gamma_1}$, $\overline{\delta_1}$ and the mean of the group we shall call g_1, which is $\frac{\overline{a_1} + \overline{\beta_1} + \overline{\gamma_1} + \overline{\delta_1}}{4}$. $\overline{g_1}$ may be taken as giving an estimate of the mean amount of direct penetration and drip on the plot taken over the twenty-five days, as the four gauges were arranged symmetrically around it. The next group of positions G_2 with corresponding readings will naturally be written A_2, B_2, C_2, D_2; a_2, β_2, γ_2, δ_2, g_2; $\overline{a_2}$, $\overline{\beta_2}$, $\overline{\gamma_2}$, $\overline{\delta_2}$, $\overline{g_2}$, and so also for the remaining groups. The expression $a_1 - g_1$ which we shall call Δa_1, gives us the departure of the A_1 reading from the mean of the plot on the day on which that reading was taken. The values of Δa_1, which vary from day to day, arise partly from the fixed position of A_1, with reference to the positions of its group G_1 and partly from very variable causes such as changes in the direction and speed of the wind, intensity and lack of homogeneity of showers, changes in canopy due to fall of leaves, etc., and the mean value of Δa_1, that is, $\overline{\Delta a_1}$ or $\overline{\Delta a_1} - \overline{g_1}$, for the twenty-five days will include both the positional and casual effects.

Statistical theory indicates that a measure of the casual effects is given by the standard deviation of the twenty-five values of Δa_1 from its mean value $\overline{\Delta a_1}$. The standard deviation,

$$\sigma\Delta a_1 = \sqrt{\frac{\text{Sum } (\Delta a_1 - \overline{\Delta a_1})^2}{n^1 - 1}}$$

where n^1 is the number of readings, in this case twenty-five, and the sum includes all the twenty-five readings. The ratio of the actual mean value $\overline{\Delta a_1}$ to the standard deviation $\sigma\Delta a_1$ allows us to state the probability that the whole value of $\overline{\Delta a_1}$ may be due to casual effects, and therefore, to give a numerical estimate of the effect of the position of the A_1 gauge with reference to the mean of its group. For instance if, with twenty-five readings, $\frac{\overline{\Delta a_1}}{\sigma\Delta a_1} = 1$, statistical theory indicates that the probability is one in three (8, p. 44 and p. 158) that the value of $\overline{\Delta a_1}$ is entirely casual. If $\frac{\overline{\Delta a_1}}{\sigma\Delta a_1} = 2$, the probability of entirely casual effects is now only one in eighteen, and the greater part of the value of the divergence of the A_1 gauge readings from the group mean would have to be regarded as due to its position. The effect of position would then be significant. The improbability of casualness increases rapidly with the value of $\frac{\overline{\Delta a_1}}{\sigma\Delta a_1}$; for example, when the ratio is 2.5, the probability of entire casualness is only one in fifty. Thus the calculation of the values of $\overline{\Delta}$ and $\sigma\Delta$ for the twenty positions of the gauges gives a reliable answer to the question of the extent to which the position of a raingauge in a forest area may affect the mean value of its readings, so as to cause a significant departure from the mean value of the readings for the whole

TABLE II.

PROBABILITY OF CASUALNESS OF DEPARTURE OF GAUGE MEAN FROM GROUP MEAN.

Group	Gauge	No. of days of rain	Mean of gauge	Mean of group	$\bar{\Delta}$	σ_Δ	$\frac{\bar{\Delta}}{\sigma_\Delta}$	Approximate probability of casualness
G_1	A_1	25	.2556	.2691	− .0135	.0073	1.85	1 in 13
	B_1	25	.3096		+ .0405	.0108	3.75	< 1 in 100
	C_1	25	.2408		− .0283	.0088	3.22	<< 1 in 100
	D_1	25	.2704		+ .0013	.0064	0.20	about .9
G_2	A_2	31	.2948	.2641	+ .0308	.0072	4.28	< 1 in 100
	B_2	31	.2900		+ .0260	.0069	3.77	<< 1 in 100
	C_2	31	.2874		+ .0233	.0121	1.93	1 in 16
	D_2	31	.1842		− .0800	.0196	4.08	< 1 in 100
G_3	A_3	37	.3332	.3151	+ .0183	.0071	2.58	1 in 65
	B_3	37	.2965		− .0185	.0106	1.75	1 in 11
	C_3	37	.2854		− .0295	.0096	3.07	<< 1 in 100
	D_3	37	.3451		+ .0300	.0078	3.85	<< 1 in 100
G_4	A_4	30	.1013	.1173	− .0160	.0386	0.41	about .7
	B_4	30	.1183		+ .0010	.0062	0.16	about .9
	C_4	30	.1213		+ .0040	.0038	1.05	3 in 10
	D_4	30	.1283		+ .0110	.0046	2.26	1 in 35
G_5	A_5	26	.2465	.2374	+ .0093	.0075	1.24	1 in 4
	B_5	26	.2242		− .0133	.0100	1.33	1 in 5
	C_5	26	.2146		− .0228	.0103	2.21	1 in 32
	D_5	26	.2642		+ .0268	.0102	2.63	1 in 70

area. It is clear from the results tabulated in Table II, that in three-fourths of the cases a large fraction of the divergence of the mean reading of a gauge from the mean reading of its group is due to its position. In the case of group G_2, the position D_2 which lay close to and south-east of a tree trunk, is attended by abnormally low readings, clearly arising from the sheltering action of the trunk, and this has made $\overline{\Delta\alpha_2}$, $\overline{\Delta\beta_2}$, $\overline{\Delta\gamma_2}$, $\overline{\Delta\delta_2}$ all very large, while the values of the corresponding standard deviations are not greatly changed. The effect of position is therefore very marked in this case. This particular result, however, is an important one as an instance of the large variations in direct penetration and drip, which have to be taken into account when estimating the rainfall in a forest. The group G_4 is interesting. Though the number of days on which penetration was recorded, is thirty, the mean of the group per day is only .1173 with the natural result that the divergences of the single gauge mean readings from this group mean are also low, and that in only the case of D_4 is the standard deviation markedly less than the mean deviation, $\overline{\Delta\delta_4}$. With small rainfall penetrations, then, readings are likely to be affected to a marked fractional extent by casual variations of wind, etc.

The second and even more important question, on which this investigation throws light, is that of the number of gauges which should be scattered through an apparently homogeneous forest area, to get an estimate of the mean amount of water reaching the area as direct penetration and drip with a pre-selected likelihood of standard error.

For this purpose, we find for each gauge the fraction by which its mean reading differs from the mean reading of its group. Thus for the gauge in the A_1 position, this fraction is $\frac{\overline{\Delta\sigma_1}}{\bar{g}_1}$, that is, $\frac{-.0135}{.2691}$ or — .0502. This fraction includes, as we have seen, the effects both of position and of variable causes. From these fractions we can calculate the standard fractional error of the daily mean of all the groups, by multiplying the square of each fraction by the number of rainy days for which it occurs, summing, dividing the sum by the total of the rainy days of all the gauges and extracting the square root. In this investigation, the standard fractional error of the final mean was 10.96 per cent. This result shows that the use, in the poplar stand, of four gauges, moved along the sides of the plot into a series of uniformly spread positions, without selection with reference to the canopy, but so placed that their centroid was the centre of the plot, caused the mean of all the measured daily amounts derived from direct penetration and drip to be subject to a standard fractional error of 10.96 per cent. The standard fractional error in a case of this kind has a chance likelihood of about one in three of being exceeded. To reduce the fractional error to another percentage, we must increase the number of gauges in proportion to the square of the reduction. Thus for n per cent. we need N gauges, where

$$\frac{N}{4} = \frac{10.96^2}{n^2}$$

Thus to reduce the standard fractional error to five per cent., we should require

$$N = 4 \times \frac{25}{120} = 19+$$

TABLE III.

MONTHLY PENETRATION AND INTERCEPTION OF RAIN.

Month	Rainfall inches	Direct penetration and Drip		Stem run-off		Total penetration		Interception %
		Inches	%	Inches	%	Inches	%	
1938								
Sept.	5.57	4.52	81.2	0.82	14.7	5.34	95.9	4.1
Oct.	3.15	2.39	75.9	0.33	10.5	2.72	86.4	13.7
Nov.	2.04	1.55	76.0	0.14	6.9	1.69	82.8	17.2
Dec.	0.53	0.41	77.4	0.04	7.6	0.45	84.9	15.1
1939								
Jan.	0.00	0.00	—	0.00	—	0.00	—	—
Feb.	2.84	2.44	85.9	0.17	6.0	2.61	91.9	8.1
Mar.	0.35	0.19	54.3	0.00	—	0.19	54.3	45.7
Apr.	4.10	3.33	81.2	0.25	6.1	3.58	87.3	12.7
May	5.20	3.96	76.2	0.70	13.5	4.66	89.6	10.4
June	2.22	1.87	84.2	0.28	12.6	2.15	96.9	3.2
July	3.69	3.06	82.9	0.47	12.7	3.53	95.7	4.3
Aug.	5.40	4.41	81.7	0.94	17.4	5.35	99.1	0.9
Totals	35.09	28.13	80.2	4.14	11.8	32.27	92.0	8.0 = 2.82 in

The very divergent mean reading of the single gauge in position D_2 causes the second group G_2 to contribute more than half to the sum of the squares of the fractions and thereby more than doubles the estimate of the number of gauges needed to produce a standard error of any specified percentage.

In future investigations in pine plantations at Jonkershoek it has been decided to use twenty gauges. To simplify the analysis of data these are to be erected at twenty fixed sites in the forest. A statistical analysis of the data yielded by these gauges, resembling that which has been described here as carried out by Professor Morrison, will be made to test the accuracy and reliability of the sampling.

The accuracy with which the penetration in the form of stem run-off was estimated, depended on the technique of catching and measuring the water, the method of converting the measured volume to the equivalent in inches of rainfall, and the method of selecting sample trees.

The technique of measuring stem run-off was very accurate. In this experiment it was found that .01 inch of rain penetrating in the form of stem run-off, was equal to a volume of water of over seven gallons caught in the tanks attached to the seven sample trees. All the run-off from the sample trees was caught and measured to the nearest tenth of a gallon. Losses due to splashing, wetting of interior of tanks etc., would have caused only insignificant errors.

Methods of converting gallons of run-off to inches of rainfall have been described and discussed above. The estimations of total annual stem run-off arrived at by the graphical and simple proportion methods differed by 2.4 per cent. Because the error is so small and the stem run-off was only 4.14 inches or 11.8 per cent. of the total penetration, the effect on the final experimental results, of using one or the other method, must be negligible. The precision of the simple proportion method, which was, therefore, adopted, may be improved by selecting the sample trees more carefully. The trees in the stand could be classified into four groups of equal basal area, and two small sample trees could then be selected as near to the mean basal area of each group as possible. The stem run-off for the stand would then be calculated by groups. Robert Hartig (23, p. 127) selected sample trees in a similar manner to determine the timber volume of stands of trees.

The relative size of the sample of stem run-off measured is equivalent to the total basal area of sample trees expressed as a percentage of the total basal area of trees in the experimental stand of a tenth acre. In the poplar bush it was equal to 31.3 per cent. This sample was so large that it was unnecessary to add more sample trees in order to obtain greater accuracy.

This examination of the accuracy with which rainfall penetration has been estimated in the poplar stand, is important chiefly because it has indicated how future investigations might be improved. It is also of value because it enables us to infer in what ways other experiments have been incomplete.

Results Obtained.

During the year of investigation, 120 daily estimations of rainfall penetration were made. These were used to obtain an equal number of estimations of interception by subtracting from the daily rainfall recorded in the open. The data have been summarised in Table III.

TABLE IV.

EFFECT OF LEAF FALL ON PENETRATION AND INTERCEPTION OF RAIN.

Period	Rainfall inches	Direct penetration and drip		Stem run-off		Total penetration		Interception %
		Inches	%	Inches	%	Inches	%	
Nov. to Mar.	5.76	4.59	79.7	0.35	6.1	4.94	85.8	14.2 = 0.82 in.
Jun. to Sep.	16.88	13.86	82.1	2.51	14.9	16.37	97.0	3.0 = 0.51 in.

In interpreting the figures tabulated, the shortcomings in experimental method and technique must not be forgotten. The annual totals of absolute penetration are fairly accurate, however. They include estimations of quite large quantities of direct penetration and drip under twenty variations in the canopy, and are independent of the doubtful records of rainfall received in the open. The relative figures of penetration and interception must be accepted with reserve. From Table III we see that 35.09 inches of rain were recorded in the open. 32.27 inches or 92.0 per cent. penetrated to the forest floor. 28.13 inches or 80.2 per cent. was direct penetration and drip and 4.14 inches or 11.8 per cent. was stem run-off. It is clear that a considerable amount of water did reach the forest floor, because, although the total interception—2.82 inches or 8.0 per cent—is probably under-estimated, the estimates of absolute penetration may be accepted as nearly correct.

The monthly totals are smaller and more subject to chance variations. This probably accounts for the very low total penetration in March when the rainfall was only .35 inches. The most striking divergences in monthly penetration are caused by the deciduous character of the trees. The very high total penetration for the year is explained by the fact that the trees were bare of leaves for the four wet months June to September when about fifty per cent. of the rain fell. During this time very little rain was prevented from reaching the ground. The records for the months when the trees were in full leaf and the months when they were quite bare are summarised in Table IV. The difference in interception—trees in leaf intercepted 14.2 per cent.; bare trees only 3.0 per cent—is very striking. The form in which water penetrated was also strongly affected. The trees in leaf allowed 79.7 per cent. of percipitation to reach the ground in the form of direct penetration and drip, and only 6.1 in the form of stem run-off, giving a total penetration of 85.8 per cent. The fall of the leaves caused the direct penetration and drip to be increased slightly to 82.1 per cent, but the stem run-off was more than doubled i.e. 14.9 per cent. The increase in stem run-off is probably due to the decrease in number of drip points caused by the absence of leaves, and to the fact that more rain could beat through directly on to the tree stems. The total penetration for bare trees was 97.0 per cent., an increase of 11.2 per cent. Percentages quoted here are not entirely correct, because of errors in the experimental technique. The comparisons of the relative amounts of interception and penetration which have been made are nevertheless justified, because all

the estimations must have been influenced in the same relative way by the experimental errors.

Few conclusions could be drawn from daily estimations of penetration and interception. The daily amounts of rainfall were small and subject to relatively large chance variations. The divergences in estimations of the amount of direct penetration and drip were large, because, with only four gauges, the mean value was strongly affected by variation due to the positions the gauges happened to occupy (see above). The number of observations made—56 when trees were without leaves and 27 when trees were in leaf—was not large enough to calculate accurate daily means of penetration for various amounts and intensities of rainfall. If more observations of greater accuracy had been available it would have been possible to determine the important correlations between the amount of precipitation, its intensity and the amounts of penetration and interception. The available daily measurements lead to one definite, almost self-evident conclusion, that the amount of daily penetration increases with the increase in the amount of daily rain. Other conclusions are tentative.

The characteristic differences in penetration and interception, associated with the deciduous character of the trees, which have been demonstrated by the monthly totals, are confirmed by the daily readings. The measurements show no apparent correlation between the amount or percentage of interception and the amount of rainfall recorded in the open, but there are indications that more accurate data will show that the relative interception is less for large amounts of rainfall than for small. This is so, because the absolute interception—that is the water required to wet the leaves, twigs, branches and stems of trees—is probably more or less constant. The data further indicate that stem run-off will occur with a rain of less than .1 of an inch when the trees are bare. When the trees are in leaf, however, about .2 of an inch of rain is required before stem run-off will be recorded.

It is interesting that the penetration recorded, exceeded the rainfall on 28 out of 120 wet days. This was probably due in some cases to drip and stem run-off caused by mist condensation in the wood. In many cases, however, the excess was probably not real, but due to variations in the samples of direct penetration and drip taken under different parts of the canopy; for example, the group of gauges G_3 (A_3, B_3, C_3 and D_3), always gave high readings of penetration. The total excess of penetration over rainfall measured on the 28 days was .62 inch or 1.9 per cent. of the total penetration. Of this quantity nearly half was measured in the gauges of group G_3. The excess was not associated with days of light or heavy rain. The mean daily rain for days on which excess was recorded was .28 inch, and for the year of investigation it was .29 inch. The daily quantities of excess were small. The average was only .02 inch.

Summary

The paper deals with the study of the amount of rain intercepted by the leaves, twigs, branches and stems of trees, and lost to the forest soil mainly through evaporation. A critical account of the history of the investigation of rainfall interception is given. An experiment in a stand of poplars at Jonkershoek is then described; and, with the help of data yielded by this investigation, the experimental method and technique are discussed. It is pointed out that the method of paired stations inside and outside the forest, is not entirely satisfactory. Three improvements

are suggested: rainfall should be gauged above the canopy as well as in an adjacent open field, all guages should be sheltered from wind, and the gauging technique used in the forest should be duplicated in the open and above the canopy.

The measurements of penetration are then analysed to test the accuracy of the sampling technique. It is shown that the variation in drip and direct penetration under various parts of the canopy is considerable. To obtain a mean estimation in the poplar stand, with a pre-selected standard error of five per cent., it is calculated that more than nineteen gauges will be required. A technique for measuring stem run-off was also tested and minor improvements are recommended.

Data of rainfall interception and penetration in the poplar stand are presented. 32.27 inches of rain, or about 92.0 per cent. of downpour in the open, reached the forest floor. The penetration and interception varied greatly in amount and nature, according to whether the trees were in leaf or bare. Direct penetration and drip through trees in leaf was 79.7 per cent.; through bare trees 82.1 per cent. Stem run-off from trees in leaf was 6.1 per cent.; from bare trees 14.9 per cent. Interception by trees in leaf was 14.2 per cent.; by bare trees 3.0 per cent.

The daily estimations of penetration and interception were too few and too inaccurate to determine satisfactorily the correlation between them and daily amounts and intensities of rainfall. The data indicated that some penetration in the form of drip and stem run-off may have been derived from mist condensation on leaves, twigs, branches and stems of trees.

References

1. Beall, H. W.: The penetration of rainfall through hardwood and softwood forest canopy. *Ecology* 15 : 412-415. 1934.
2. Brooks, C. E. P.: The Influence of Forests on Rainfall and Run-off. *Quar. Jr. Royal Met. Soc.* 54: 1-17. 1928.
3. Bühler, A.: Der Waldbau Teil I. Eugen Ulmer Stuttgart. 1918.
4. Burger, H.: Waldklimafragen. *Mitt. d. schweiz. Centralanstalt f.d. Forst. Versuchsw.* 17: 92-149. 1931.
5. ——— Waldklimafragen. *Mitt. d. schweiz. Centralanstalt f.d. forst. Versuchsw.* 18: 1-192. 1933.
6. Davis, W. E.: Measurements of Precipitation above Forest Canopies. *Jr. of F.* 37: No. 4, 1939.
7. de Forest, H.: Rainfall Interception by Plants: An Experimental Note. *Ecology* 4: 417-19. 1923.
8. Fisher, R. A.: Statistical Methods for Research Workers. Oliver and Boyd. London. 1936.
9. Holch, A. E.: Development of roots and shoots of certain deciduous tree seedlings in different forest sites. *Ecology* 12: 259-298. 1931.
10. Horton, R. E.: Rainfall interception. *Mo. Weath. Rev.* 47: 603-623. 1919.
11. Linke, F.: Niederschlagsmengen unter Bäumen. *Meteor. Zeitschr.* 1921.
12. Marloth, R.: Results of Experiments on Table Mountain for ascertaining the Amount of Moisture deposited from the south-east clouds. *Trans. S.A. Phil. Soc.* 14: 403-408. 1903.
13. ——— Results of further Experiments on Table Mountain for ascertaining the Amount of Moisture deposited from the south-east clouds. *Trans. S.A. Phil. Soc.* 16: 97-105. 1905.
14. Maule, W. L.: Comparative values of certain forest cover types in accumulating and retaining snowfall. *Journ. Forestry.* 32: 760-765. 1934.
15. Mitchell, J. A.: Interception of rainfall by the forest. *Journ. For.* 28: 101-102. 1930.
16. Phillips, J. F. V.: Rainfall Interception by Plants. *Nature.* 116: 837. Dec. 1926.
17. ——— Rainfall Interception by Plants. *Nature.* 118: March 1928.

18. ———— Forest Succession and Ecology in the Knysna Region. Govt. Prin., Pretoria, S.A., 1931.
19. RIEGLER, W.: Beobachtungen über die Abfuhr meteorischen Wassers entlang den Hochstämmen. *Mitt. a.d. forst. Versuchsw. Osterreichs.* II. 1879.
20. RUBNER, K.: Der Nebelniederschlag im Wald und seine Messung. *Thar. Forstl. Jahrb.* 1932.
21. RUBNER, K.: Die pflanzengeographische-ökologische Grundlagen des Waldbaus. Neumann-Neudamm. 1934.
22. SIMSON, A. G.: The interception of summer rains by forest cover. *For. Res. Notes. Proc. N. W. For. Exp. Sta.* (Mimeo). 1931.
23. TISCHENDORF, W.: Lehrbuch der Holzmassenermittlung. Paul Parey, Berlin. 1927.
24. TOUMEY, J. W.: and KORSTIAN, C. F.: Foundations of Silviculture upon an ecological Basis. John Wiley and Sons. 1937.
25. WICHT, C. L.: A Preliminary Account of Rainfall in Jonkershoek. *Trans. of the Royal Soc. of S.A.* 28: 161-173. 1940.
26. ———— Forest Influences Research Technique at Jonkershoek. *Journ. of the S.A. For. Assoc.* No. 3: 65-80. 1939.
27. WOOD, O. M.: The Interception of Precipitation in an Oak-Pine Forest. *Ecology.* 18: No. 2. 1937.
28. ZON, R.: Forests and Water in the Light of Scientific Investigations. Govt. Ptg. Office, Wash., U.S.A. 1927.
29. Co-operative Progress Report by the Division of Agric. Engin. of the U.S. Dept. of Agric. Rainfall Penetration and Consumptive Use of Water. Bull. 33. 1930.
30. Dept. of Agric. and For. Forests in Relation to Climate, Water Conservation and Erosion. Govt. Prin., Pretoria. 1935.
31. Lake States Forest Experimental Station. Interception of rainfall by the forest. Tech. Note. 14. 1929.
32. United States Dept. of Agric. Influence of Vegetation and Watershed Treatments on Run-off, Silting and Streamflow. Miscellaneous Publ. No. 397. 1940.

SOUTH AFRICAN WATTLE BARK AND WATTLE EXTRACT WITH SPECIAL REFERENCE TO THE AMERICAN MARKET

By I. J. CRAIB

(*Chief Forest Research Officer, Pretoria.*)

Statement prepared for the information of representatives of South African trade and tanners in the United States.

THE South African wattle industry is about 60 years old. From its humble origin in 1886, when bark to the value of £11 was exported to Great Britain, it has steadily expanded to its present extent which exceeds half a million acres within the Union.

There are four species of tan-wattles in South Africa. They are all of Australian origin and, in several respects, are similar to each other in appearance. They are the black wattle (*Acacia mollissima* Willd.), the green wattle (*A. decurrens* Willd.), the golden wattle (*A. pycnantha* Benth.) and the silver wattle (*A. dealbata* Link.). Only black wattle is grown commercially in South Africa for bark production. Although green wattle exhibits certain pest-resistant qualities, it is no longer planted on account of the undue redness of its extract. Bark of the golden wattle is not available in sufficient quantities for export, and bark of the silver wattle is so inferior in its tannic acid content, that its sale under the name of "black wattle" is prohibited by Government proclamation. The bark at present exported from the Union is composed almost exclusively of black wattle.

Wattle bark is one of the richest vegetable tanning materials known. Mature air-dried bark has a tannic acid content of about 35 per cent., and being an astringent catechol (green reaction with ferric salts) tan is used mainly for the tanning of sole leathers. It readily blends with other vegetable tans which are acid-forming, however, and in this form is used for the tanning of a wide range of hides and skins.

TABLE I.

TONNAGE AND VALUE OF BARK AND EXTRACT EXPORTED.

Year	Bark, long tons (2,240 lbs.)	Extract, long tons (2,240 lbs.)	Total value	Average value (f.o.b.) per long ton	
				Bark	Extract
			£	£ s. d.	£ s. d.
1886	——	——	11	——	——
1896	3,380	——	16,460	4 17 6	——
1906	14,828	——	89,374	6 0 0	——
1916	50,868	439	269,794	5 0 0	34 0 0
1926	80,441	18,207	917,167	7 7 0	18 16 0
1930	73,044	15,714	863,894	7 12 0	19 12 0
1935	83,340	34,383	767,632	4 11 3	11 5 5
1936	74,165	34,236	776,905	4 14 10	12 10 1
1937	68,452	40,864	1,000,901	6 4 2	14 1 10
1938	64,656	29,005	907,952	7 0 0	15 14 0
1939	97,935	41,237	1,307,052	7 2 0	14 18 0
1940	72,522	58,662	1,507,562	7 10 11	16 7 5

Growth and Distribution of the Wattle Industry

Table I presents statistically the growth of the wattle industry in South Africa in terms of tonnage and value of both bark and extract exported.

The total value of bark and extract exported up to and including 1920 was £5,300,000 and from 1921 to the end of 1940 was over £17,400,000 making a grand total of over £22,700,000. In addition the present annual revenue from the local consumption of wattle wood in the form of mining timber, firewood and charcoal, is estimated to exceed half a million pounds sterling.

The wattle industry is situated mainly in Natal. Table II shows the distribution and rate of extension of wattle areas within the Union up to the time of the last agricultural census.

TABLE II.

Areas Afforested with Tan Wattles in South Africa.

Province	Acreage in undermentioned years				
	1908	1921	1926	1930	1937
Cape	——	15,071	27,776	36,043	35,418
Natal	147,778	222,211	230,618	379,351	362,811
Transvaal	——	49,163	49,051	111,866	136,489
Orange Free State	——	1,245	1,938	2,389	1,279
Totals	147,778	287,690	309,383	529,649	535,997

During the past decade there has been little expansion of the area under production. The sale of wattle wood, which is a by-product of the wattle bark industry, is essential if bark is to be exported on a profitable basis in competition with other vegetable tanning materials. As the gold mines of the Transvaal have reached the point of saturation in their consumption of wattle wood for mine-prop purposes, future expansion of the wattle industry is likely to be slow unless further major uses for wattle wood can be developed.

Silvicultural Reorganization of the Industry

Until 1928, when the Forest Department instituted an intensive programme of research upon wattle silviculture, the industry was conducted almost entirely upon agricultural lines. Since then, however, production technique has been drastically modified because of the results of this investigation. The work of the author (1, 2, 3) and others (4, 5, 6) has shown that wattles respond significantly when managed according to the principles of forestry. The following is a brief statement of the site requirements and management practice which have yielded optimum results.

Areas suitable for wattles.

The wattle is a rapidly growing tree which reaches a height of 40 to 60 feet in the average rotation period of 8 to 10 years. Commercially successful plantations are limited to deep well-drained soils which are subjected to a minimum rainfall of 35 inches per annum, and lie within

the altitudinal range of 1,500 to 4,500 feet above sea level in the zone of summer rainfall. The species is not hardy to frost.

Soil preparation.

When starting new plantations the soil is thoroughly ploughed, fallowed over winter and harrowed in spring prior to sowing. In regenerating felled plantations natural regeneration is used wherever possible.

Treatment of seed and sowing.

To induce rapid germination wattle seed is placed in boiling water, thereafter remaining immersed in this water for 12 hours while it cools off. Sowing is usually done between November and March in rows 6 to 9 feet apart.

Early spacing and grass control.

Within 4 to 6 weeks of germination, the most vigorous seedlings are spaced to about 1,200 trees per acre. All grass, weed and wattle regrowth is rigidly controlled by hoeing during the first 18 months, and thereafter only the perennials are destroyed.

Fertilising.

The fertilising of all young wattle stands with 200 to 400 lbs. of super-phosphate per acre is recommended.

Non-burning.

On clear-felling plantations the brushwood, remaining after the stripping of the bark, is piled densely in narrow lines along the contours to prevent erosion, to increase organic content of the soil and to ameliorate productive soil-moisture factors. The introduction of the practice of non-burning in place of broadcast burning of the slash after clear-felling, previously carried out almost universally in the industry, has radically transformed the outlook for sustained and perpetual production.

Thinning.

Before the end of the second year the 1,200 seedlings per acre, referred to previously, are thinned in stages to their final espacement of between 250 and 400 trees per acre, at which densities the stands are matured. These thinnings, together with the other measures already enumerated, are vital to the production of rapid growth, high yields, thick bark of superior quality and low costs per ton of bark and wood produced.

Rotation and yields per acre.

Wattle plantations are clear-felled at 8 to 10 years of age. Yields per acre under normal conditions vary from 3 to 6 tons of air-dry bark, depending upon site quality and efficiency of management. About half the bark produced in South Africa is dried in the open but protected against rain to prevent degrade. The balance is sent to extract factories immediately after stripping.

Protection.

Numerous insects and diseases afflict the industry (5, 6). Amongst the former the worst are bagworm and froghopper. Bagworm is controlled by hand and aeroplane dusting with cryolite and froghopper by hand-dusting with pyrethrum.

Grading of Wattle Bark

In 1936 a Departmental Committee was appointed to investigate the marketing and export of wattle bark. Their report (21) analysed the position regarding production, harvesting, drying and marketing of wattle bark prior to this date, and drew attention to the need for re-organization, improvement and standardization of wattle products shipped to overseas markets. Shortly afterwards, compulsory grading of wattle bark, recommended in this report, was instituted by proclamation under the Forest Act. Grading of wattle bark is undertaken by the Government and it is compulsory that every parcel of bark be marketed upon the basis of the grade assigned to it. The following comprises the various grades:—

Grade	*Mark*	*Standard*
South African Chopped Prime	SA/CP	Extra heavy or thick well dried mature bark of good external appearance and fracture. (N.B. the term "good external appearance" implies good colour, absence of undue amounts of corkiness and absence of mould and/or other fungus disease).
Shouth African Chopped Average	SA/CA	Well dried, mature bark of average thickness, colour and homogeneity. (N.B. Homogeneity precludes the mixing of extremes of thickness and/or colour).
South African Chopped Merchantable	SA/CM	Well dried bark of good colour and other well dried bark of colour below average.
South African Ground Prime	SA/GP	Well shredded, well dried bark of light colour, good weight and even texture.
South African Ground Average	SA/GA	Well shredded, well dried bark of even texture and average colour.
South African Ground Merchantable	SA/GM	Well shredded, well dried thin bark of good colour, and well shredded bark of colour below average.

Although all bark, whether chopped or ground, is graded by means of visual inspection only, there is the cloest correlation between visual grading and chemical analysis as shown in Table III. The data cover the past three years.

The agreement between the grader's estimates and the chemical analyses is extraordinary and it is obvious that there are no significant differences between the figures in any of the grades (special credit is due to Mr. E. A. Goodwin, Government Grader of Wattle Bark, and his staff for the excellence of these results).

TABLE III.

CORRELATION BETWEEN VISUAL GRADING AND CHEMICAL ANALYSIS OF WATTLE BARK.

Grades	No. of samples	Grader's estimate			Government analysis		
		Mean tan per cent.	Standard deviation	Standard deviation as percentage of mean	Mean tan per cent.	Standard deviation	Standard deviation as percentage of mean
SA/CP	21	38.79	0.86	2.2	39.50	1.36	3.4
SA/CA	212	36.46	0.81	2.2	36.50	1.43	3.9
SA/CM	56	35.09	1.12	3.1	35.09	1.75	5.0
SA/GP	54	37.37	0.61	1.6	37.29	1.59	4.3
SA/GA	82	35.96	1.20	3.3	35.76	1.30	3.6
SA/GM	151	34.09	0.92	2.7	33.66	1.24	3.7

QUALITIES OF WATTLE TANS

As already stated, wattle tans are available to leather tanners in the form of bark (chopped or ground) or extract. Extract is usually manufactured from green (freshly stripped) bark. Approximately 3 to 3.4 tons of green bark and 1.8 to 2 tons of dry bark are required to produce one ton of extract. As indicated in Table III wattle bark has a tannic acid content varying between 34 and 39 per cent., depending upon the grade, a moisture content of approximately 12.5 per cent., a soluble non-tan content of approximately 10.5 to 11.5 per cent. and an average of 3.5 to 4.5 units of red colour and 6 to 7 units of yellow colour in its infusion. There is an appreciable fall in red colours as the grade of bark rises. South African wattle extract is solid and while its tannic acid content is guaranteed to be at least 60 per cent. it frequently contains a tan content of 63 per cent. The red units in wattle extract are usually appreciably lower than those of wattle bark whereas the other qualities of extract remain unchanged relative to bark.

According to Williams (7) wattle tans give an infusion of good colour so that the resulting leather is light in colour, having only a faint pinkish tinge. Wattle bark or extract can be stored for very long periods of time without showing appreciable deterioration. The tanning matter is readily extracted from wattle bark at comparatively low temperatures, over 90 per cent. being extracted at temperatures as low as 15° to 30°C. Wattle tans blend well with most other tanning liquors to give a satisfactory mixed tannage. It also tends to dissolve the refractory soluble tanning matter in other liquors with which it is mixed.

Wattle liquors are considered to comprise a rather astrigent tanning material (7) due primarily to the low proportion of acid-forming compounds in the liquor. They contain appreciable quanties of sugar (8) which give rise to a fermentation which comes to an end when the sugar has been exhausted. Wattle tans are very useful in the manufacture of sole leather, including the finishing processes. After adjustment with added acids, it is successfully used in hot-pits in place of chestnut. After sulphiting it is used considerably as a bleach liquor. Sulphited wattle tans could be used for many purposes in place of sulphited quebracho (8). Wattle leather is firm and durable (9).

Competitive Tanning Materials

Natural tanning materials are very widely distributed throughout the vegetable kingdom. Professor Bernardin (10) has listed and classified 350 plants, shrubs and trees which yield tannic acid in quantities sufficient for use in the tanning of leather. Few of them are used for commercial purposes, however, and still fewer have found a place in international trade in tanning materials. With regard to international trade the only vegetable tanning materials in addition to wattle worthy of note here are quebracho, myrobalans, chestnut, valonia, sumach, gambier, mangrove, divi-divi, algarobilla, oak-bark and oak-wood, cutch and hemlock.

Quebracho.

This tree (*Schinopsis balansae*) is common in the Argentine and also occurs in Chili and Paraguay. Quebracho extract is made from the wood which contains about 25 to 28 per cent. of a red tannin which dissolves with difficulty. Quebracho extract contains 40 to 60 per cent. of tannin (11). It is one of the most important tanning materials in the world and, like wattle, is an astringent catechol tan. Many quebracho extracts are now made completely soluble by treatment with alkaline bisulphites or by treatment with alkali which is afterwards neutralised (10).

Myrobalans.

Myrobalans is the name given to the un-ripe fruits of various species of *Terminalia* in India, of which *Terminalia Chebula* is the most important. These nuts contain about 30 per cent. of tannin (9, 10). Myrobalans are one of the most important tannin materials of the pyrogallol (blue reaction with ferric salts) class. The tannin is not very astringent and penetrates the hide so slowly that it is usually used in combination with wattle, quebracho or other astringent tans. When used alone they yield a soft, mellow and rather spongy leather which does not possess good wearing qualities (9). One of the principal properties of myrobalans is their acid-forming power.

Chestnut.

Chestnut extract of commerce is almost, if not entirely, made from the wood of the Chestnut (*Castanea sativa* and *Castanea dentata*). The former grows abundantly in Italy, South of France, Spain and Corsica and the latter in the Atlantic States of the United States of America. The wood contains 8 to 13 per cent. of tannin (9). Chestnut extract tans hides and skins rapidly, giving a firm leather, and is used largely in Great Britain for the tanning of sole leather when used in blend with myrobalans and other materials. The American extract contains about 29 per cent. of tannin and the French and Italian about 27 per cent. (9). Chestnut supplies in America have been greatly curtailed owing to the widespread destruction of the trees by blight.

Valonia.

Valonia comprises the cups of the fruits of certain oaks, mainly *Quercus aegilops*. Valonia contains between 30 and 40 per cent. of tannins and is obtained mostly from Greece and Asia Minor. The tannins are principally pyrogallol derivatives which are notable for the bloom which they impart to leather (10).

Sumach.

Sumach is derived from *Rhus coriaria,* a native of the European countries bordering the Mediterranean, the commercial supply being obtained almost exclusively from plants cultivated in Sicily (9). It comprises the leaves of the shrub in the ground form and contains 22 to 32 per cent. of tannin. Sumach belongs to the pyrogallol group and is the best tanning material known for pale colour and soft tannage, and is hence widely used for the tanning of morocco, glove, book-binding and upholstery leathers (10).

Gambier.

Gambier is a solid extract prepared from the leafy twigs of *Uncaria gambier,* a climbing shrub which is cultivated in the East Indies and Malaya. Gambier is very variable in quality and contains from 20 to 60 per cent. of tannins (9, 10). When used alone gambier gives a rather spongy leather, but when used in conjunction with wattle and myrobalans, it is suitable for both heavy and light leather (9).

Mangrove.

Mangrove bark is obtained from a wide range of trees or shrubs belonging to the natural order *Rhizophoraceae.* They all inhabit muddy swamps close to the seashore and the mouths of rivers in tropical countries, where they frequently form forests of vast extent. They occur mainly in India, Indo-China, Federated Malay States, Phillipine Islands, West and East Africa, Southern United States, Central and South America. The barks are very variable in their tannin contents, ranging between 20 and 40 per cent. Mangrove bark has the disadvantage of imparting a dark red colour to leather (9).

Divi-divi.

Divi-divi is the name applied to the pods of the *Caesalpinia coriaria* which is indigenous to Mexico, West Indies, Venezuela, Colombia and North Brazil. The pods contain an average of 40 to 45 per cent. of pyrogallol tannin. When used alone in tannage, divi-divi pods yield a leather which is strongly affected by climatic conditions and are therefore generally blended with other materials (9).

Algarobilla.

This tanning material is derived from the pods of *Caesalpinia brevifolia* which contain about 45 per cent. of tannin and is very similar in character to divi-divi except that it is less prone to discolouration. The world is dependent upon Chili for supplies which are apt to be very irregular (9).

Oak-bark and Oak-wood.

Almost all species of oaks contain useful quantities of catechol tannin in their bark and frequently also in their wood. The most notable tan-oaks in Europe are *Quercus pedunculata* and *Q. sessiliflora* and in the United States *Q. montana* (11). Extract is seldom made from bark, which has a tannin content of about 10 per cent., but the wood, with a tan content of only 7 per cent. is almost invariably extracted prior to use in the tan-pits (9, 10). Oak is one of the oldest and best known of the tanning materials suitable for sole and other heavy leathers. As it is expensive and slow of penetration into the hides, it is now almost always used in combination with other vegetable tans.

Cutch.

Cutch, in its original meaning, is an extract obtained from the wood of *Acacia cutechu,* a tree native to India and Burma. It contains about 60 per cent. of tannin and its use in the pure form is unsatisfactory as it imparts a yellow stain to leather which is apt also to be harsh (9). The name "cutch" is now used also for several other extracts, the most important of which is the extract of mangrove bark.

Hemlock.

Hemlock bark (from the trees *Tsuga canadensis* and *T. heterophylla*) contains 8 to 14 per cent. of tannin and is widely used for the tanning of sheepskins, sole and heavy leathers generally, in the United States and Canada where it is indigenous. Extracts are now available with a tannin content as high as 30 per cent.

Non-vegetable Tannins.

Chromium salts derived from chrome iron ore are widely used for the dressing of leather. Chromium salts penetrate hides and skins very rapidly, the process taking days instead of the weeks or months necessary for the process of tanning with vegetable tans (12). Leathers made from chromium salts are both durable and waterproof, but have, nevertheless, serious drawbacks. Stather (13) states that well greased vegetable tanned leather is 10 to 100 times as permeable to air as a corresponding chrome leather. Boots made of chrome leather cause burning of the feet, swell and stretch unduly when wet relative to boots made from vegetable tanned leather. Wilson (14) states that the tensile strength, permeability, porosity and resilience of vegetable tanned leather are superior to similar chrome dressed leather and that only in wearing quality is chrome leather superior.

Synthetic or artificial materials for the dressing or curing of leather have also been on the market for the past 30 years. Williams (7) states that the total amount of synthetic materials used in commerce comprises only a minute fraction of the vegetable tans used. There is apparently little likelihood that synthetic materials will supercede natural tan stuffs to any considerable extent because of the high price and limited utility of the former. Moreover, the true tannins are so complicated in their chemical structure that it is hardly likely that similar compounds will be produced artificially at a cost that will be competitive with the production of natural tans (7).

Before concluding this section, attention must also be drawn to the keen competition afforded by rubber and rubber composition products to leather in many industries. While rubber products have actually succeeded in ousting leather for many purposes, the world consumption, both actual and potential, of genuine leather is consistently increasing.

Comparison of Wattle with Other Vegetable Tans

An advanced knowledge of organic chemistry is required if the processes, to which leather is subjected during tanning, are to be fully understood. As such technical detail is beyond the scope of this statement, only the more simple comparisons between the various commercial vegetable tans are given here. It must be stated at the outset that no vegetable tan is superior to other competitive vegetable tans in all respects. Almost all tans have special qualities which give them particular value because

of such qualities. This explains why tannages in the pits are almost invariably blended.

As already stated, wattle bark is one of the richest raw tanning materials known. The following list, given by Williams (7), compares the tannic acid contents of the various raw materials commonly in use.

Raw tanning material.	*Percentage tanning matter.*
Algarobilla	43
Divi-divi	41
Wattle bark	35
Mangrove bark	33
Myrobalans	32
Valonia	32
Sumach	27
Quebracho	20
Oak bark	12
Chestnut bark	11
Hemlock bark	10
Gambier	5

Wilson (15) determined the rate of penetration into hide of various tannin extracts at their natural acidity values. The number of days taken for these extracts to penetrate the hide completely, varied from 10 to 33 days. The order of increasing time of penetration was as follows: bisulphited quebracho (10 days), wattle (11 days), chestnut (14 days), cutch (16 days), raw quebracho (18 days), hemlock (19 days), valonia (20 days), oak (30 days), myrobalans (33 days). Wattle, though highly astringent, is the most rapidly penetrating natural extract.

Strather and Herfeld (16) when comparing gambier, valonia, quebracho, wattle, oak, chestnut, sumach, myrobalans and mangrove found that chestnut and quebracho possess the ability of fixing tans in the hide at the greatest rate, and that quebracho and wattle have the ability of fixing them in the greatest amounts.

Considering wattle from the point of view of economy of tanning material, there are several factors which render it superior to most of its rivals. One of the chief of these factors is the small loss of tannin through the formation of insoluble deposits in the tan liquors (12). The percentage losses in tans and non-tans from this cause, found by Paessler (17), are given in Table IV.

TABLE IV.

PERCENTAGE LOSSES DUE TO FORMATION OF INSOLUBLE DEPOSITS IN TAN LIQUORS.

Source of tan	Percentage loss in tans	Percentage loss in non-tans	Total percentage loss
Gambier	.0	37	37.0
Mangrove bark	.0	2	2.0
Sumach	1.5	16	17.5
Wattle bark	2.0	35	37.4
Quebracho	3.4	35	38.4
Oak bark	7.5	60	67.5
Chestnut	11.5	1	12.5
Oak wood	12.5	5	17.5
Myrobalans	24.0	42	66.0
Valonia	29.0	30	59.0
Divi-divi	29.0	22	51.0

It is apparent that wattle is highly stable in solution compared with most other tans, and loses very little of its tannic acid during the process of tanning.

With regard to losses in tanneries due to mould growth, Lloyd (18) found that goatskins tanned with various liquors and kept under conditions favourable to mould growth, showed much mould growth for gambier and sumach, fair mould growth for chestnut, sulphited quebracho and myrobalans and only slight mould growth for oak-bark, ordinary quebracho and wattle.

Stather and Schubert (19) found that when tanned at the natural acidities of the various vegetable tans the resulting leathers were increasingly poor in colour in the following order: sumach, myrobalans, chestnut, valonia, wattle, gambier, oak-bark, natural quebracho, sulphited quebracho. With regard to the tensile strength and stretch of leathers, these authorities found that wattle leathers were stretchy in relation to those of competitive materials, and only medium in tensile strength. They found that wattle "wettability" (the relative time taken for a drop of water to be absorbed into leather) is longer than that for oak, myrobalans, chestnut, quebracho and sumach. The shrink temperature for leather tanned with wattle was one of the highest obtained, namely 87°C.

The following figures have been published (Leather Trade Review, 58, 627, 1925) showing the relative gains in weight (due to absorption of tans and non-tans) of the dry pelt caused by some of the chief commercial tanning materials. It will be seen that the weight-producing properties of wattle are not notably good according to this authority.

Tanning material.	*Percentage gain in weight of dry pelt.*
Oak bark	105.6
Valonia	103.4
Oak wood	102.7
Chestnut	99.6
Quebracho extract	99.1
Quebracho wood	98.4
Wattle bark	94.5
Hemlock	93.4
Myrobalans	75.6

World Trade in Vegetable Tanning Materials

The most recent statistics available upon world trade in vegetable tanning materials, are those contained in an editorial appearing the "Leather World" (Vol. 29, No. 1394, 1937). As the various tanning materials tend to differ appreciably in the amounts of tannins which they contain, all materials in these data are reduced to the actual units of tannic acid contained in them, for comparative purposes. The data are given in Table V.

Several points of special interest emerge from a study of this table. The international trade in oak, mangrove, divi-divi, algarobilla, hemlock and gambier is so small that none of these materials finds a place in these data. They tend, in other words, to be more of local than international importance. On the other hand, quebracho supplies over 60 per cent. of international trade in tanning materials, and maintained its position

TABLE V.

International Trade in Vegetable Tanning Materials

Year	Quebracho		Wattle bark and extract		Myrobalans and myrobalans extract		Chestnut extract		Valonia		Sumach	
	Tannin units in tons	Percentage of world trade	Tannin units in tons	Percentage of world trade	Tannin units in tons	Percentage of world trade	Tannin units in tons	Percentage of world trade	Tannin units in tons	Percentage of world trade	Tannin units in tons	Percentage of world trade
1927	183,900	63.5	41,300	14.2	32,600	11.2	16,600	5.7	11,300	3.9	4,400	1.5
1928	192,400	69.7	31,600	11.5	21,200	7.6	15,500	5.6	11,000	4.0	4,300	1.6
1929	147,000	65.5	29,800	13.2	20,600	9.2	12,500	5.5	11,200	5.0	3,600	1.6
1930	138,400	62.4	34,200	15.4	21,200	9.5	14,700	6.6	9,900	4.5	3,600	1.6
1931	147,900	67.0	30,300	13.7	20,400	9.2	11,200	5.0	8,100	3.7	3,000	1.4
1932	163,300	70.7	30,500	13.3	17,600	7.7	7,100	3.1	9,200	4.0	2,700	1.2
1933	185,100	71.5	33,100	12.8	20,800	8.0	7,700	3.0	9,400	3.6	2,800	1.1
1934	189,800	70.8	36,200	13.5	22,800	8.5	5,200	1.9	11,900	4.4	2,300	0.9
1935	151,900	62.0	48,900	20.0	25,000	11.2	6,300	2.6	10,400	4.2	2,700	1.1
1936	143,100	63.0	45,700	20.1	22,000	9.7	5,600	2.5	9,100	4.0	1,700	0.7

throughout this decade despite an appreciable drop in the tonnage of tannin units exported. It is the world's most important source of tanning matter and constitutes over 85 per cent. of the tanning materials imported into the United States and 40 per cent. of the amount consumed there (11).

While wattle bark and extract supply only about one third of the tannin units in world trade relative to quebracho, they supply more tans than all the other tanning materials added together.

There was, moreover, an appreciable rise in the percentage contribution of wattle tans to world trade during this period. Whereas myrobalans and valonia maintained their relative positions during the 10 years in question, it is not known how significant is the appreciable drop in production of both chestnut extract and sumach.

Export Trade in Wattle Bark and Extract

Almost all wattle bar kand extract on international markets is produced in the Union of South Africa. Kenya, the next most important producing country, produced only 7 per cent. as much bark and 20 per cent. as much extract as did the Union in 1938 and 12 and 16 per cent. respectively in 1939. Australia, Tanganyika, Java, Morocco and Madagascar also export wattle bark, but only in negligible quantities.

Tables VI and VII show the countries to which South Africa exports wattle bark and wattle extract. They also provide information as to the relative importance to South Africa of the various importing countries. It will be seen that prior to the war Great Britain, India, Germany, Holland and Japan consumed the great bulk of the South African exports of wattle bark. During 1940 Great Britain, India and Japan consumed approximately 95 per cent. of bark exports between them, over 55 per cent. being consumed by India alone. With regard to extract Great Britain has always been South Africa's most notable customer, very much smaller amounts being consumed, prior to the war, by the other main extract purchasing countries, namely Germany, Holland, Belgium and Japan. Since the war Great Britain has purchased almost 70 per cent. of the output of South African extract, with the bulk of the remainder going to Japan, New Zealand, Australia and China.

Consumption of Tanning Materials in the United States

Probably more tanning materials are consumed in the United States of America than in the rest of the world added together. The most recent data obtainable (20) on this consumption are given in Table VIII for the year 1937.

During 1937 (a normal year) America consumed over 238,000 tons of tanning extract and over 85,000 tons of imported raw tanning materials. This consumption equals almost three-quarters of the total international trade in leather tans. A further point of interest seen from this table is that chestnut extract, relatively unimportant in international trade (see Table V), is the second most important world tanning material, and that the great bulk of it is manufactured and consumed in the United States.

Trade With the United States

Table IX shows the tonnages of bark and extract produced in the Union, the tonnages of these products purchased by the United States and the percentage relationship between total production in the Union and

TABLE VI.

South African Export Trade in Wattle Bark.

Importing country	YEAR							
	1930		1935		1938 Last normal pre-war year		1940	
	Tons (2,240 lbs.)	Percentage of total export	Tons (2,240 lbs.)	Percentage of total export	Tons (2,240 lbs.)	Percentage of total export	Tons (2,240 lbs.)	Percentage of total export
Great Britain	21,081	28.9	14,380	17.3	6,656	10.3	12,272	17.0
India	10,749	14.7	15,757	18.9	15,318	23.7	39,930	55.0
Australia	30	0.0	95	0.1	105	0.2	723	1.0
New Zealand	1,184	1.6	581	0.7	202	0.3	798	1.1
Mauritius	50	0.1	9	0.0	13	0.0	4	0.0
Palestine	5	0.0	46	0.1	20	0.0	27	0.0
Belgium	12,857	17.6	1,108	1.3	1,124	1.7	25	0.0
Finland	200	0.3	—	—	—	—	—	—
Denmark	139	0.2	—	—	—	—	—	—
France	882	1.2	297	0.4	116	0.2	785	1.1
French Colonies	21	0.0	140	0.2	138	0.2	—	—
Germany	9,718	13.3	14,559	17.5	9,845	15.2	—	—
Holland	803	1.1	16,217	19.5	9,399	14.5	—	—
Italy	333	0.5	1,075	1.3	966	1.5	—	—
Norway	300	0.4	65	0.1	114	0.2	—	—
Spain	498	0.7	458	0.6	—	—	512	0.7
Sweden	708	1.0	826	1.0	837	1.3	—	—
China	819	1.1	417	0.5	759	1.2	258	0.4
Japan	8,938	12.2	9,173	11.0	13,858	21.4	16,287	22.5
U.S. America	3,494	4.8	6,586	7.9	3,116	4.8	470	0.7
Egypt	218	0.3	35	0.0	132	0.2	168	0.2
Latvia	20	0.0	49	0.1	59	0.1	—	—
Ceylon	—	—	6	0.0	117	0.2	70	0.1
Tzechoslovakia	—	—	25	0.0	353	0.6	—	—
Tripoli	—	—	26	0.0	—	—	—	—
Poland	—	—	1,093	1.3	1,058	1.6	—	—
Jugoslavia	—	—	311	0.4	—	—	—	—
Manchukuo	—	—	5	0.0	—	—	—	—
Hong Kong	—	—	—	—	295	0.5	—	—
Austria	—	—	—	—	25	0.0	—	—
Bulgaria	—	—	—	—	9	0.0	—	—
Portugal	—	—	—	—	20	0.0	—	—
Syria	—	—	—	—	—	—	—	—
Hungary	—	—	—	—	—	—	197	0.3

TABLE VII.

South African Trade in Wattle Extract.

Importing country	YEAR							
	1930		1935		1938 Last normal pre-war year		1940	
	Tons (2,240 lbs.)	Percentage of total export	Tons (2,240 lbs.)	Percentage of total export	Tons (2,240 lbs.)	Percentage of total export	Tons (2,240 lbs.)	Percentage of total export
Great Britain	5,964	38.0	14,621	42.5	14,954	51.6	39,710	68.7
India	36	0.2	129	0.4	182	0.6	1,231	2.1
Australia	24	0.2	95	0.3	404	1.4	2,592	4.5
New Zealand	322	2.0	472	1.4	504	1.7	1,572	2.2
Mauritius	32	0.2	48	0.1	50	0.2	55	0.1
Belgium	894	5.7	1,281	3.7	1,072	3.7	270	0.5
France	510	3.2	84	0.2	243	0.8	—	—
Germany	4,366	27.8	3,483	10.1	944	3.3	—	—
Holland	978	6.2	2,245	6.5	1,212	4.2	199	0.3
Italy	322	2.0	205	0.6	465	1.6	—	—
Portugal	89	0.6	720	2.1	889	3.1	845	1.5
Norway	33	0.2	305	0.9	153	0.5	44	0.1
Russia	121	0.8	—	—	—	—	—	—
Sweden	80	0.5	1,420	4.1	633	2.2	683	1.2
Spain	329	2.1	518	1.5	—	—	92	0.2
China	271	1.7	780	2.3	502	1.7	2,433	4.2
Japan	998	6.3	1,917	5.6	2,430	8.4	5,504	9.5
U.S. America	125	0.8	2,074	6.0	611	2.1	569	1.0
Esthonia	60	0.5	133	0.4	236	0.8	—	—
Egypt	136	0.9	66	0.2	41	0.1	435	0.7
Denmark	20	0.1	196	0.6	142	0.5	373	0.6
Hong Kong	—	—	30	0.1	1,012	3.5	118	0.2
Palestine	—	—	20	0.1	—	—	34	0.1
Finland	—	—	322	0.9	310	1.1	15	0.0
Dutch East Indies	—	—	162	0.5	237	0.8	—	—
Latvia	—	—	35	0.1	295	1.0	—	—
Poland	—	—	252	0.7	—	—	—	—
Roumania	—	—	97	0.3	53	0.2	83	0.2
Switzerland	—	—	40	0.1	—	—	—	—
Jugoslavia	—	—	30	0.1	197	0.7	34	0.1
Thailand	—	—	17	0.1	219	0.8	—	—
Bulgaria	—	—	—	—	10	0.0	40	0.1
Tzechoslovakia	—	—	—	—	356	1.2	—	—
Hungary	—	—	—	—	453	1.6	475	0.8
Persia	—	—	—	—	54	0.2	—	—
Ceylon	—	—	—	—	—	—	63	1.1

TABLE VIII.

CONSUMPTION OF TANNING MATERIALS IN THE UNITED STATES FOR THE YEAR 1937.

Material	Extract produced internally in tons (2,240 lbs.)	Imported	
		Raw product in tons (2,240 lbs.)	Extract in tons (2,240 lbs.)
Chestnut	162,370	—	—
Sumach	1,855	—	—
Logwood (unspecified)	—	17,031	—
Myrobalans	—	20,587	—
Quebracho wood	—	13,655	—
Sumach	—	1,596	—
Valonia	—	11,352	—
Gambier	—	2,060	—
Wattle bark	—	8,353	—
Oak galls	—	1,255	—
Other (crude)	—	9,528	—
Quebracho	—	—	63,580
Mangrove	—	—	7,177
Other (extract)	—	—	3,362
Totals	164,225	85,417	74,119

TABLE IX

TRADE IN WATTLE BARK AND EXTRACT WITH THE UNITED STATES.

Year	Bark in tons (2,240 lbs.)			Extract in tons (2,240 lbs.)		
	Total production in Union	Exports to U.S.A.	Percentage consumed by U.S.A.	Total production in Union	Exports to U.S.A.	Percentage consumed by U.S.A.
1932	56,761	378	0.7	18,696	162	1.0
1933	67,518	3,129	4.6	16,876	537	3.2
1934	65,844	3,797	5.8	22,954	915	4.0
1935	83,340	6,586	7.9	34,383	2,074	6.0
1936	74,165	6,410	8.6	34,236	1,494	4.4
1937	68,452	1,695	2.5	40,864	2,253	5.5
1938	64,656	3,116	4.8	29,005	611	2.1
1939	97,935	1,583	1.6	41,237	1,630	4.0
1940	72,522	470	0.7	58,662	569	1.0

purchases by the United States from 1932 to 1940.

A study of this table shows that the United States have always been a small buyer of South African wattle products. It shows also that during the past 5 to 6 years there has been a marked decline in American purchases of these commodities from the Union, despite the fact that, as shown in Table I, the past two years have been record years regarding both production and revenue in this industry.

FACTORS FAVOURABLE TO AN INCREASE OF TRADE WITH THE UNITED STATES

Present international circumstances greatly favour a considerable increase in the importation by the United States of wattle bark and extract from the Union of South Africa. The factors currently promoting such increase in trade are detailed as follows:—

1. Wattle bark and wattle extract are two of the most valuable and extensively used tanning materials in the British Empire, and are meeting

with greatly increased popularity with British tanners (9). This assessment of the value of wattle tans on world markets is corroborated by the extensive lists of foreign buyers of these products enumerated in Tables VI and VII.

2. The South African industry, supplying the great bulk of wattle products on world markets, is in a state of optimum health. Recently re-organised technique, regarding both production and pest control, has placed the industry on a basis of permanent and sustained yield. The industry, moreover, is capable of considerable expansion if overseas markets warrant it.

3. The institution of the policy of compulsory Government grading of wattle bark into three grades, in 1937, is a vital safeguard and guarantee of quality to overseas buyers. No complaints regarding the quality of wattle bark exported during the past four years have been received from overseas buyers of wattle bark. Wattle extract also, is a standardised product with a guaranteed tan content of 60 per cent.

4. As shown in Table V wattle tans rank second only to quebracho in international trade in tanning materials. From Table VIII it is seen that because of chestnut extract in the United States, wattle tans rank third in world importance. These three materials, quebracho, chestnut and wattle, fall within the same tanning group and can, therefore, replace each other to a considerable extent. What are the prospects for sustained production in wattle's two main competitors in the American market?

In an extract from "Hides and Leather and Shoes" (Vol. 98/11 Sept. 9, 1939) Sr. Ricardo Marzorati, Hon. Secretary of the Centres of Quebracho Exporters, frankly admitted that there is the possibility that South African wattle will eventually displace quebracho. He stated that owing to its slow growth, no scheme of re-afforestation with quebracho could adequately meet the present rate of exploitation. He stressed the need for investigating the possibility of growing wattles in the Argentine to replace, gradually, the quebracho industry, which has sufficient natural resources to tide over any experimental or later transitional period from one source of supply to another.

5. The future prospects for the maintenance of the production of chestnut extract in the United States are even less favourable than those for the production of quebracho in the Argentine. It will not be possible for the United States to maintain her supplies of chestnut raw material due to the unfortunate introduction of a fungus *Endothia parasitica,* in the second decade of this century, which has almost completely eliminated the species *Castanea dentata,* the main tan-bearing chestnut. Numerous publications on this subject are available from the United States Forest Service.

6. The dislocation of international trade in tanning materials under existing circumstances, does not seriously affect the prospects of trade between the Union and the United States. Chestnut from France, Corsica and Italy is now almost unobtainable; sumach from Spain, Sicily and Cyprus is scarce and expensive. Numerous other countries, exporters of tanning materials before the war, find supplies for export curtailed owing to domestic acceleration in their production of war supplies. South Africa, on the other hand, only a small producer of leather goods, has a large exportable surplus of wattle products due to the loss of her European markets in these commodities.

7. Quite apart from the closer trade relationships between the British Empire and the United States, which have been developed as a direct outcome of the war, the balance of trade between the United States and the Union of South Africa is extremely favourable to the former. This balance can be made more equitable through the purchase by the United States of considerably increased quantities of South African wattle bark and extract, basic raw materials which she urgently needs.

8. Per unit of tannic acid, wattle tans, like quebracho, chestnut and mangrove are amongst the cheapest tanning materials known. From Table I it will be seen that there has been no substantial increase in the prices (f.o.b. South African ports) of South African wattle bark or extract. The increases shown are due almost exclusively to the rise in the cost of the imported materials (fuels for transport, vehicles, hessian, wire, etc.) necessary for the transport and packing of these commodities. An additional factor which greatly favours an increase in the importation of these products by the United States is the favourable exchange rate. On current rates the American dollar has appreciated by approximately 17 per cent. relative to the £ sterling.

Conclusion

In concluding this brief review of the South African wattle industry with special reference to the American market, it may be of interest to examine the reasons underlying the apparent restriction in trade in wattle tans between these two countries. The foremost reasons are probably lack of precise knowledge of the qualities of wattle tans and lack of experience in the use of them on the part of American tanners. Increased trade will doubtless remedy these factors.

A further reason is possibly the objection which has been raised by certain American importers against the price control for bark and extract in South Africa. They maintain that this is a monopolistic influence which precludes these importers from obtaining any but the same price quotations for bark and extract from all South African exporters. These controls are actually exercised by the South African Bark Millers' and Exporters' Association and the South African Wattle Extract Manufacturers' Association respectively. In this connection it must be strongly emphasised, however, that these bodies are recognised and approved by the Government which regularly scrutinises the transactions of these bodies who voluntarily submit to such scrutiny. Prices of bark and extract are fixed from time to time relative to other tanning materials on world markets, and this action has the approval of the Government as one of the main factors promoting stability in the industry.

Union bark and extract also suffer in competition with similar products exported from East Africa through misconception regarding their relative properties and prices. All bark exported from East Africa is designated *Fair Average Quality* (F.A.Q.), whereas bark exported from the Union is classified into the three grades: *Prime, Average* and *Merchantable* according to standards fixed by Government regulations. The tendency is to compare the Union *Average* grade with the East African F.A.Q., which, on the most recent information available, is quoted at 2 dollars less, per ton, c.i.f. It must, however, be emphasized that the few chemical analyses available support the contention that the East African product is equal only to the Union *Merchantable* grade. On the basis of units of tannin the prices of the Union and East African products are therefore approximately

identical. Similarly, wattle extract exported from East Africa is quoted on the New York market (c.i.f.) at 0.125 cents per pound lower than extract from the Union. In this matter, also, there is apparently ample justification for the contention that the tannic acid content of the East African extract is approximately 3 per cent. lower than the similar product from the Union, thus bringing the prices of the two similar commodities into general agreement.

REFERENCES.

1. CRAIB, I. J.: Points on Wattle Production. For Dept. Bull. No. 28, 1934.
2. ————: The Wattle Industry in South Africa Br. Emp. For. Con. 1935.
3. ————: The Place of Thinning in Wattle Silviculture and its Bearing on the Management of Exotic Conifers. *Zeit. f. Weltforstwirtschaft* Ver. Neumann, Neudamm und Berlin. 1934.
4. STEPHENS, R. P.: Mining Timber in South Africa with Special Reference to Wattle Silviculture. *Jour. S.A. For. Assen.* No. 4. 1940.
5. LEDEBOER, M. S. J.: Developments in Pathological Research on Wattles. *Jour. S.A. For. Assen.* No. 4. 1940.
6. RIPLEY, L. B. and PETTY, B. K.: Possibilities of Combating Wattle Bagworm with Insecticidal Dusts. *S.A. Jour. Sci.* Vol. 29. 1932.
7. WILLIAMS, C. O.: South African Tanning Materials. S.A. Dept. Agr. Sci. Bull. No. 106. Part III. 1932.
8. LLOYD, D. J.: The Vegetable Tanning Materials of the British Empire. *The Leather World.* Vol. XXXII No. 1553. 1940.
9. Imperial Institute: Tanning Materials of the British Empire. Bull. Imp. Inst. 1929.
10. PROCTER, H. R.: The Principles of Leather Manufacture. E. & F. Spon, Ltd., 57 Haymarket, London. 1936.
11. HILL, A. F.: Economic Botany. McGraw-Hill Book Co. N.Y. 1937.
12. SHUTTLEWORTH, S. G.: A Study of Problems connected with the Leather and Allied Industries of South Africa. Part III of Report 5 from the Tanning, Hides and Skins Res. Dept. Rhodes Univ. Coll. 1938.
13. STATHER, F.: From abstract which appeared in the *Jour. Int. Soc. Lea. Tr. Chem.* Mar. 1938.
14. WILSON, J. A.: The Chemistry of Leather Manufacture Chem. Catalog Co. N.Y.
15. ————: Comparative Values of Tanning Extracts. *Hide and Leather,* 91 No. 11, 24, 1936.
16. STATHER, F. and HERFELD, H.: Chemie und Technologie der pfkanzlichen Gerbung Collegium 797, 497, 1936.
17. PAESSLER: Quoted by "Prefix" in Tanning Materials. *Lea. Trades Review,* 68, 749, 1935.
18. LLOYD, J. D.: Troubles in Leather Manufacture caused by Moulds. *Lea. Trades Review.* 47, 197. 1934.
19. STATHER, F. and SCHUBERT, R.: Ueber den spezifischen Einfluss pfkanzlichen Gerbextrakte auf die Eigenschaften des damit gegerbten Leders Collegium 776, 609. 1934.
20. Statistical Abstract of the United States. U.S. Dept. Comm. 1939.
21. Departmental Committee: Grading and Marketing of Wattle Bark. S.A. Dept. Agr. 1936.

NATIVE NAMES IN USE IN SWAZILAND FOR TREES SHRUBS AND OTHER PLANTS

By O. B. MILLER

(*Forest Officer for Bechuanaland Protectorate and Swaziland.*)

IT is hoped that this list will be found useful in Zululand as well as in Swaziland, for there is but little difference between the two languages. The Swazis often change the Zulu "z" into "t" and "d" into "dz." Thus the Zulu words "i-Nyamazi" and "um-Dakane" become in Swazi "i-Nyamati" and "um-Dzakane."

A word as to phonetics for those who have no knowledge of Bantu Nguni languages. The vowels are pronounced as in Italian, "a" as in "bar," "e" as in "bay," "i" as in "been," "o" as in "both" and "u" as in "brute." The letter "h" is an aspiration added to the preceding consonant which otherwise retains its own sound value. For instance "ph" does not as in English become "f." The combination "hl" is as in the Welsh "ll." The letter "r" is the guttural like "g" in Afrikaans, and "g" is always hard. Although ordinarily "c" is the sole click occurring in Swazi, Zulu influence seems to have imposed the use of "q" and "x" in special connections, at any rate in the naming of plants. This may be due to the fact that Zulu text-books are used in the schools. There are none in Swazi. Zulu influence certainly accounts for the use all over the country of two or three names for one plant. Where this occurs one of the names will be found to be of Zulu origin. It is in view of this that the phrase "Native Names in Use in Swaziland" is incorporated in the title of this article in preference to "Swazi names."

The symbol (!) after native names in the first list means that the preceding name has been recorded by the writer. Names without this mark have been taken from the lists kindly lent by Lt.-Col. B. Nicholson, formerly Government Secretary, Swaziland, Mr. A. G. Marwick, formerly Resident Commissioner, and Mr. H. Hutchinson, of the Empire Cotton Growing Corporation.

Where the generic name only is given, owing to doubt as to species, the number following in brackets refers to specimens in the herbaria of the Imperial Forestry Institute, Oxford, and of the Division of Botany, Pretoria, to both of which bodies I am indebted for identifications.

The common English and Afrikaans names have not been included as they are nowadays easily obtained from Floras and other less expensive publications. In fact the last number of this Journal contains a most comprehensive Afrikaans list by Dr. C. L. Wicht.

As remarked in a previous contribution, "the comparatively primitive inhabitant of the bushveld is a good botanist, but his brother of the Western hill country is not." This might well be borne in mind by collectors in Swaziland.

All specific names in the lists that follow have been decapitalised in conformity with resolution viii(b) of the Fourth Empire Forestry Conference.

Botanical Names with Native Equivalents.

Botanical name.	*Native name.*
Acacia arabica *var.* kraussiana *Benth.*	isi-Twetwe !
	um-Ncawe
ataxacantha *DC.*	lu-Gagane !
borleae *Burtt Davy*	lu-Bibi
davyi *N.E.Br.*	um-Gamba !
heteracantha *Burch.*	isi-Twetwe
karroo *Hayne*	um-Dongolo
	Kalimela
	isi-Nga !
nigrescens *Oliv.*	um-Kaya !
	um-Kayana !
permixta *var* glabra *Davy*	lu-Bibi !
swazica *Davy*	Kaimela
	Kalimela
xanthlophloea *Benth.*	um-Hlafunga
species (*Miller S/248*)	um-Bambampala !
species	isi-Puze
Acokanthera venenata *G.Don*	in-Hlungunyembe !
Adina galpini *Oliv.*	umu-Hlume !
Afzelia quanzensis *Welw.*	um-Kolikoli
	um-Shamfuti (*in Portuguese E.A.*)
Albizzia versicolor *Welw.*	um-Vangatana !
Aloe *species*	in-Hlaba !
Amaranthus paniculatus *L.*	im-Buya
thunbergii *Moq.*	i-Sheke
Androstachys johnsonii *Prain*	ubu-Kunku !
Anona senegalensis *Pers.*	um-Telembu
Anthocleista zambesiaca *Baker*	um-Hobohobo
Antidesma venosum *Tul.*	in-Hlalamahubulu !
	Hubulu !
Apodytes dimidiata *E.Meyr.*	um-Dakane !
	um-Dzakane !
Balanites maughamii *Sprague*	um-Nununu !
Barbacinia *species*	isi-Fundi !
Bauhinia punctata *Bolle*	i-Sololo !
Bolusanthus speciosus (*Bolus*) *Harms*	umu-Hohlo !
Boscia rehmanniana *Pest.*	in-Gcotho !
	um-Phisi
Brachylaena natalensis *Sch. Bip.*	um-Pahla !
Buddleja salvifolia *Lam.*	um-Batacwepe !
Burchellia bubalina *Sims.*	ma-Hlozana !
Capparis tomentosa *Lam.*	in-Kunzibomvu
Carissa arduina *Lam.*	um-Betankunzi !
Cassia petersiana *Bolle*	li-Joyi !
Cassine eucleaeformis (*Sond.*) *O.Ktze.*	u-Sasatye !
papilosa *O.Ktze.*	um-Batangcwepe !
schlecteri *Loes.*	in-Gulutane
Cephalanthus natalensis *Oliv.*	um-Fomfo !
Chaetachme aristata *Planch.*	um-Bangabangwe !
Chloristylis rhamnoides *Harv.*	in-Dhlenyati !
Chrysophyllum magalismontanum *Sond.*	um-Numbela !
natalense *Sond.*	um-Tshongane !
Species (*Miller S/249*)	a-Mazinatole !
Clausena inaequalis *Benth.*	um-Nukelambiba !
Cliffortia linearifolia *E.&Z.*	in-Tsanyelo !
Colocasia antiquorum *Schott*	ema-Dumbe
Combretum apiculatum *Sond.*	um-Bondo mnyama !
griseiflorum *S.Moore*	um-Dubu !
imberbe *v.* petersii (*Klot.*) *E.&D.*	um-Pondozendhlovu !
zeyheri *Sond.*	um-Bondo omhlope !
Commiphora caryaefolia *Oliv.*	u-Mumbe !
Species nr. C. calciicola *Eng.*	ili-Minyela

Botanical name.	*Native name.*
Commiphora *species*	u-Mubu !
	umu-Bu !
Crassula parvisepala *Schonl.*	in-Gulamlomo !
Crocosmia pottsii *N.E.Br.*	isi-Ndwendweni !
Croton gratissimus *Burch.*	um-Huluka
Curtisia faginea *Ait.*	ili-Ncayi !
	isi-Nwati !
	um-Poyi
Cussonia paniculata *E.&Z.*	um-Senge !
spicata *Thunb.*	um-Senge !
umbellifera *Sond.*	um-Sengambute !
Cyathea dregei *Kze.*	in-Komakomo !
Dais cotinifolia *L.*	in-T(f)ocwane !
Dalbergia armata *E.Meyr.*	um-Gcope !
Dichrostachys glomerata (*Forsk.*) *H.&D.*	um-Setyane !
	um-Silazembe !
	i-Segwane !
Diospyros mespiliformis *Hochst.*	um-Toma
Dissotis princeps (*Bonpl.*) *Triana*	um-Pongaponga !
Dombeya rotundifolia *Hochst.*	mu-Wane !
Dracaena hookeriana *C.Koch*	isi-Konkwane
Ehretia rigida (*Thunb.*) *Bruce*	um-Xele
Ekebergia meyeri *Presl.*	i-Nyamati !
	isi-Tshelete
Elaeophorbia acuta *N.E.Br.*	um-Hlonthlo !
Eleusine corocana *Gaertn.*	lu-Phoko
Erythrina caffra *Tunb.*	um-Nsinsi !
latissima *E.Meyr.*	i-Hlangu !
	isi-Pama !
Erythrophloeum guineense *G.Don*	um-Kanku !
guineense *var.* swazica *B. Davy*	um-Hlahla !
Erythroxylon brownianum *B. Davy*	i-Jobe !
	i-Zaza !
Eugenia zeyheri *Harv.*	in-Bindzangolube
natalensis *Sond.*	i-Jobe !
Euphorbia *species*	um-Hlonthlo !
Fadogia fragrans *Robyns*	in-Dhlaleni
Fagara capensis *Tunb.*	um-Nungwane !
Faurea saligna *Harv.*	isi-Qalaba !
Ficus capensis *Thunb.*	um-Kiwane !
pretoriae *Burtt Davy*	in-Dhlaleni
sonderi *Miq.*	um-Kokoko !
stuhlmannii *Warb.*	um-Kokoko !
Galpinia transvaalica *N.E.Br.*	um-Dubu !
Garcinia livingstoniana *And.*	isi-Nyula
	isi-Pula
Gardenia neuberia *E.&Z.*	lu-Pembetu !
obovata *Stapf.*	um-Valasangweni !
Gerrardina foliosa *Oliv.*	ma-Luleka !
Grewia caffra *Meisn.*	li-Klolo !
flavescens *Juss.*	um-Sipane
Species nr. Pole Evans 3403	Lalinyati
Greyia radlkoferi *Szyszy.*	in-Dhlebelembila !
Gymnosporia acuminata (*L.F.*) *Szyszy.*	um-Nama !
buxifolia *Szyszy.*	isi-Hlangu !
rubra *Loes.*	in-Gcenane !
senegalensis (*Lam.*) *Loes.*	isi-Hlangu !
Halleria lucida *L.*	um-Binda !
Harpephyllum caffrum *Bernh.*	um-Gwenye !
Heteromorpha *Species*	um-Bangandhlala !
Heteropyxis canescens *Oliv.*	in-Kunzi !
natalensis *Harv.*	in-Kunzi !
Hippobromus pauciflorus *Rad.*	lu-Twile !
Homalium subsuperum *Sprague*	um-Holompunzi !

Botanical name.	*Native name.*
Ilex mitis *Radlk.*	li-Bota !
Ipomoea batata *Poir.*	u-Batata !
Kigelia pinnata *DC.*	um-Vongoti !
Lannaea discolor (*Sond.*) *Eng.*	isi-Kanganyane !
	in-Tokolovu
Lippia asperifolia *Rich.*	mu-Tswane !
Lonchocarpus capassa *Rolfe*	isi-Homuhomu !
Lopholaena platyphylla *Benth.*	isi-Dwata !
Loranthus *species*	i-Pakama !
Maba natalensis *Harv.*	Tshikwane
Maesa lanceolata *Forsk.*	um-Bohlobohlo !
	um-Bongabonga !
	ma-Gucu !
Mimusops zeyheri *Sond.*	um-Pushane !
Mundulea sericea (*Willd.*) *Greenway*	um-Sindanhlovana !
Myrsine africana *L.*	um-Qanca !
Ochna natalitia *Forsk.*	isi-Fubasangala !
Olea africana *Mill.*	um-Nquma !
macrocarpa *C.H.Wright*	isi-Timane !
woodiana *Knobl.*	Manyatsi
	ma-Nyatsi
Oncoba spinosa *Forsk.*	um-Tongwane !
Ormocarpum trichocarpum (*Taub.*) *Harms*	isi-Tibane !
	isi-Tsibane !
setosum *Burtt Davy*	Sekela
Pappea capensis *var.* radlkoferi *Schinz.*	li-Latsa !
Parinarium capense *Harv.*	um-Valandhlebe
mobola *Oliv.*	um-Kuna !
Peddiea africana *Harv.*	in-T(f)ocwane !
Peltophorum africanum *Sond.*	isi-Kabakombe !
Pennisetum *species*	Gabane
	li-Tshakana
	in-Tweka
Phaseolus mungo *L.*	i-Gomeni
Phragmites communis *L.*	um-Hlanga !
Pittosporum viridiflorum *Sims*	um-vusamvu !
Plectroniella armata *Robyns*	i-Sangonsango
Podocarpus falcatus (*Thunb.*) *R.Br.*	um-Sonti
	um-Sontsi !
henkelii *Stapf.*	um-Sontsi !
Popowia caffra (*Sond.*) *Baillon*	li-Bunza !
	um-Xope !
Portulacca oleracea *L.*	isi-Lele
Protea *species*	isi-Dhlunge !
Protorhus longifolius *Engl.*	im-Fuce !
	um-Hlangoti !
Psychrotria capensis *Vatke*	u-Dzilidzili omhlope !
Ptaeroxylon obliquum (*Thunb.*) *Radlk.*	um-Thati !
Pteridium *species*	u-Hlanzafuku !
Pterocarpus angolensis *DC.*	um-Vangati !
rotundifolius (*Sond.*) *Druce*	in-Dhlebezindhlovu !
Pygmaothamnus chamaedendrum (*O.Ktze*)*Rbns.*	umKunguluzane !
Rapanea melanophleos (*L.*) *Mez.*	u-Dzilidzili !
	i-Gcolo
	lo-Qolokulu
Rauwolfia *species*	um-Kamamasi !
Rhamnus prinoides *L'Herit.*	li-Nyenye !
zeyheri *Sond.*	um-Neyi !
Rhoicissus capensis (*Burmf.*) *Planch.*	isi-Nwati !
rhomboideus (*E.Meyr.*) *Pl.*	isi-Nwati !
Rhus *species*	in-Thlangutshane !
	in-Thlangutshiyane !
Royena guerkei *O.Ktze.*	um-Cafudane !
lucida *L.*	is-Anthinyane !
	mu-Citamuzi !

Botanical name.	*Native name.*
Royena pallens *Thunb.*	i-Bota
Salix woodii *Seem.*	um-Nyetane !
Sanseviera thyrsiflora *Thunb.*	isi-Tokotoko
Sarcostemma viminale *R.Br.*	in-Gcotshwa
Sclerocarya caffra *Sond.*	um-Ganu !
Sclerochiton harveyanus *Nees.*	ma-Zabuka !
Schotia brachypetelata *Sond.*	u-Mutwa
	um-Vovovu !
Scolopia mundtii *Warb.*	um-Thabane !
zeyheri *Szyszy.*	um-Tapana !
species	in-Gcwenwane !
Solanum nigrum *L.*	um-Sobo
Spirostachys africana *Sond.*	um-Tomboti !
Sterculia rogersii *N.E.Br.*	u-Lumba !
	ulu-Mba !
Strelitzia augusta *Thunb.*	in-Kamangu !
Strychnos gerrardi *N.E.Br.*	i-Hlala !
henningsii *Gilg.*	um-Nonono !
mitis *S. Moore*	um-Patankosi !
spinosa *Lam.*	um-Hlala !
	um-Kwakwa !
Syzygium cordatum *Hochst.*	um-Gcosi !
	um-Ngcosi !
Tarchonanthus galpinii *Hutch. & Phill.*	Qoboqobo !
Teclea *species* (*T.gerrardii*?)	li-Leta
Tecomaria capensis *Spach.*	ma-Lungana !
Terminalia phanerophlebia *Eng.&Diels.*	Mangwe !
sericea *Burch.*	um-Honono !
Thespesia populnea *Cav.*	um-Gcweba
	um-Gcweleba
Trema guineensis (*Schum.*) *Ficalha*	um-Balalaqane !
Trichelia emetica *Vahl.*	um-Kuhlu !
Trichocladus grandiflora *Oliv.*	i-Nyenyane !
Trimeria grandifolia (*Hochst.*) *Warb.*	isi-Candamashane !
	ma-Hlebe !
Vangueria infausta *Burch.*	i-Mandulu !
Vepris lanceolata *Don*	i-Motane !
Vigna sinensis *Savi ex Hassk.*	Tihlumayo
Vitex reflexa *H.H.W.P.*	ama-Kosikati !
Voandzeia *species*	Hindlubu
Ximenia americana (*L.*) *Marloth*	ama-Tunduluka !
caffra *Sond.*	ama-Tunduluka !
Xymalos monospora *Baill.*	isi-Phisimakata !
Zizyphus mucronata *Willd.*	um-Lahlabantu !
	um-Pafa !

Native Names with Botanical Equivalents

Native name.	*Botanical name.*
is-Anthinyane	Royena lucida
um-Balalaqane	Trema guineensis
um-Bambampala	Acacia *species* (*Miller S*/248)
um-Bangabangwe	Chaetachme aristata
um-Bangandhlala	Heteromorpha *species*
um-Batacwepe	Buddleja salvifolia
um-Batangcwepe	Cassine papilosa
u-Batata	Ipomea batatas
um-Betankunzi	Carissa arduina
lu-Bibi	Acacia borleae
	Acacia permixta *var.* glabra
um-Binda	Halleria lucida
Bindzangolube	Eugenia zeyheri
um-Bohlobohlo	Maesa lanceolata
um-Bondo omhlope	Combretum zeyheri
um-Bondo omnyama	Combretum apiculatum
um-Bongabonga	Maesa lanceolata
um-Bongoti	Maesa lanceolata
i-Bota	Ilex mitis
	Royena pallens
umu-Bu	Commiphora *species*
li-Bunza	Popowia caffra
im-Buya	Amaranthus paniculatus
um-Cafudane	Royena guerkei
isi-Candamashane	Trimeria grandifolia
mu-Citamuzi	Royena lucida
um-Dakane	Apodytes dimidiata
in-Dhlaleni	Fadogia fragrans
	Ficus pretoriae
in-Dhlebelembila	Greyia radlkoferi
im-Dhlebezendhlovu	Pterocarpus rotundifolius
in-Dhlenyati	Chloristylis rhamnoides
isi-Dhlunge	Protea *species*
um-Dongolo	Acacia karroo
um-Dubu	Combretum griseiflorum
	Galpinia transvaalica
ema-Dumbe	Colocasia antiquorum
isi-Dwata	Lopholaena platyphylla
um-Dzakane	Apodytes dimidiata
u-Dzilidzili	Rapanea melanophleos
u-Dzilidzili omhlope	Psychotria capensis
um-Fomfo	Cephalanthus natalensis
isi-Fubasangala	Ochna natalitia
im-Fuce	Protorhus longifolius
isi-Fundi	Barbecenia *species*
Gabane	Pennisetum *species*
lu-Gagane	Acacia ataxacantha
um-Gamba	Acacia davyi
um-Ganu	Sclerocarya caffra
in-Gcenane	Gymnosporia rubra
i-Gcolo	Rapanea melanophleos
um-Gcope	Dalbergia armata
um-Gcosi	Syzygium cordatum
un-Gcotho	Boscia rehmanniana
in-Gcotshwa	Sarcostemma viminale
um-Gcweba	Tarchonanthus galpinii
um-Gcweleba	Tarchonanthus galpinii
in-Gcwenwane	Scolopia *species*
in-Gomeni	Phaseolus mungo
ma-Gucu	Maesa lanceolata

Native name.	*Botanical name.*
in-Gulamlomo	Crassula parvisepala
in-Gulutane	Cassine schlecteri
um-Gwenye	Harpephyllum caffrum
in-Hlaba	Aloe *species*....
um-Hlafunga	Acacia xanthophloea
um-Hlahla	Erythrophloeum guineense
i-Hlala	Strychnos gerrardii
	Strychnos spinosa
in-Hlalamahubulu	Antidesma venosum
um-Hlanga	Phragmites communis
um-Hlangoti	Protorhus longifolia
i-Hlangu	Erythrina latissima
isi-Hlangu	Gymnosporia buxifolia
u-Hlanzafuku	Pteridium *species*
ma-Hlebe	Trimeria grandifolia
um-Hlelanyamatana	Euclea lanceolata
um-Hlonthlo	Elaeophorbia acuta
	Euphorbia *species*
ma-Hlozana	Burchellia bubalina
umu-Hlume	Adina galpini
um-Hlunganyembe	Acokanthera venenata
um-Hobohobo	Anthocleista zambesiaca
umu-Hohlo	Bolusanthus speciosus
um-Holompunzi	Homalium subsuperum
isi-Homuhomu	Lonchocarpus capassa
um-Honono	Terminalia sericea
Hubulu	Antidesma venosum
um-Huluka	Croton gratissimus
i-Jobe	Erythroxylon brownianum
	Eugenia natalensis
li-Joyi	Cassia petersiana
isi-Kabakombe	Peltophorum africanum
Kaimela	Acacia swazica
Kalimela	Acacia swazica
um-Kamamasi	Rauwolfia *species*
in-Kamangu	Strelitzia augusta
isi-Kanganyane	Lannaea discolor
um-Kanku	Erythrophleum guineense
mu-Kaya	Acacia nigrescens
um-Kayana	Acacia nigrescens
um-Kiwane	Ficus capensis
li-Klolo	Grewia caffra
um-Kokoko	Ficus sonderi
	Ficus stuhlmannii
um-Kolikoli	Afzelia quanzensis
in-Komankomo	Cyathea dregei
isi-Konkwane	Dracaena hookeriana
ama-Kosikati	Vitex reflexa
um-Kuhlu	Trichelia emetica
um-Kuna	Parinarium mobola
um-Kunguluzane	Pygmaeothamnus chamaedendrum
ubu-Kunku	Androstachs johnsonii
in-Kunzi	Heteropyxis canescens
	Heteropyxis natalensis
in-Kunzibomvu	Capparis tomentosa
um-Kwakwa	Strychnos spinosa
um-Lahlabantu	Zizyphus mucronata
Lalinyati	Grewia *species* (*nr. Pole Evans* 3403)
li-Latsa	Pappea capensis *var.* radlkoferi
isi-Lele	Portulacca oleracea
li-Leta	Teclea *species* (T. Gerrardii?)
ma-Luleka	Gerrardina foliosa
u-Lumba	Sterculia rogersii
ma-Lungana	Tecomeria capensis
i-Mandulu	Vangueria infausta

Native name.	*Botanical name.*
Mangwe	Terminalia phanerophlebia
Manyatsi	Olea woodiana
a-Mazinatole	Chrysophyllum *species* (*Miller S*/249)
ulu-Mba	Sterculia rogersii
li-Minyela	Commiphora *species* (*nr.* C.calciicola)
i-Motane	Vepris lanceolata
u-Mubu	Commiphora *species*
u-Mumbe	Commiphora caryaefolia
u-Mutwa	Schotia brachypetelata
um-Nama	Gymnosporia acuminata
isi-Ndwendweni	Crocosmia pottsii
um-Ncawe	Acacia arabica *var.* kraussiana
ili-Ncayi	Curtisia faginea
um-Neyi	Rhamnus zeyheri
isi-Nga	Acacia karroo
um-Ngcosi	Syzygium cordatum
um-Nonono	Strychnos henningsii
um-Nquma	Oleo africana
um-Nsinsi	Erythrina caffra
um-Nukelambiba	Clausena inaequalis
um-Numbela	Chrysophyllum magalismontanum
um-Nungwane	Fagara capensis
um-Nununu	Balanites maughamii
isi-Nwati	Curtisia faginea
	Rhoicissus *species*
i-Nyamati	Ekebergia meyeri
ma-Nyatsi	Olea woodiana
i-Nyenyane	Trichocladus grandiflora
li-Nyenye	Rhamnus prinoides
um-Nyetane	Salix woodii
isi-Nyula	Garcinia livingstoniana
um-Pafa	Zizyphus mucronata
um-Pahla	Brachylaena natalensis
i-Pakama	Loranthus *species*
isi-Pama	Erythrina latissima
um-Patankosi	Strychnos mitis
lu-Pembetu	Gardenia neuberia
um-Phisi	Boscia rehmanniana
im-Phisimakata	Xymalos monospora
lu-Phoko	Eleusine coracana
um-Pondozendhlovu	Combretum imberbe *var.* petersii
um-Pongaponga	Dissotis princeps
um-Poyi	Curtisia faginea
isi-Pula	Garcinia livingstoniana
um-Pushane	Mimusops zeyheri
isi-Puze	Acacia *species*
isi-Qalaba	Faurea saligna
Qoboqobo	Tarchonanthus galpinii
lo-Qolokulu	Rapanea melanophleos
um-Sangonsango	Plectroniella armata
u-Sasatye	Cassine eucleaeformis
i-Segwane	Dichrostachys glomerata
Sekela	Ormocarpum setosum
um-Sengambute	Cussonia umbellifera
um-Senge	Cussonia paniculata
	Cussonia spicata
um-Setyane	Dichrostachys glomerata
um-Shamfuti	Afzelia quanzensis
i-Sheke	Amaranthus thunbergii
um-Silazembe	Dichrostachys glomerata
um-Sindandhlovana	Mundulea sericea
um-Sipane	Grewia flavescens
um-Sobo	Solanum nigrum
i-Sololo	Bauhinia punctata

Native name.	*Botanical name.*
um-Sonti	Podocarpus falcatus
	Podocarpus henkelii
um-Sontsi	Podocarpus falcatus
	Podocarpus henkelii
um-Tapan	Scolopia zeyheri
um-telembu	Anona senegalensis
in-T(f)ocwane	Dais cotinifolia
	Peddiea africana
um-Thabane	Scolopia mundtii
um-Thati	Ptaeroxylon obliquum
in-Thalangutshane	Rhus *species*
in-Thlangutshiyane	Rhus *species*
isi-Tibane	Ormocarpum trichocarpum
Tihlumayo	Vigna sinensis
isi-Timane	Olea macrocarpa
Tindlubu	Voandzeia *species*
in-Tocwane	Dais cotinifolia
	Peddiea africana
in-Tokolovu	Lannaea discolor
isi-Tokotoko	Sanseviera thyrsifolia
um-Toma	Diospyros mespiliformis
um-Tomboti	Spirostachys africana
um-Tongwane	Oncoba spinosa
im-Tsanyelo	Cliffortia linearifolia
li-Tshakana	Pennisetum *species*
isi-Tshelele	Euclea lanceolata
isi-Tshelete	Ekebergia meyeri
Tshikwane	Maba natalensis
um-Tshongane	Chrysophyllum natalense
isi-Tsibane	Ormocarpum trichocarpum
mu-Tswane	Lippia asperifolia
ama-Tunduluka	Ximenia americana
	Ximenia caffra
in-Tweka	Pennisetum *species*
isi-Twetwe	Acacia arabica *var.* kraussiana
	Acacia heterocanthus
lu-Twile	Hippobromus pauciflorus
um-Valandhlebe	Parinarium capensis
um-Valasangweni	Gardenia obovata
um-Vangatana	Albizzia versicolor
um-Vangati	Pterocarpus angolensis
um-Vongoti	Kigelia pinnata
um-Vovovu	Schotia brachypetelata
um-Vusamvu	Pittosporum viridiflorum
mu-Wane	Dombeya rotundifolia
um-Xele	Ehretia rigida
um-Xope	Popowia caffra
ma-Zabuka	Schlerochiton harveyanus
u-Zwilizwili	Trimeria grandifolia
i-Zaza	Erythroxylon brownianum

KORRESPONDENSIE
CORRESPONDENCE

WHAT'S IN A NAME?

To the EDITOR

Sir,

In a recently issued industrial compilation, I find in a list of South African grown woods, the words "Henkel yellowwood" assigned as the common name for *Podocarpus Henkelii* Stapf. (*P. falcata* R.Br.). I object to this. "Henkel yellowwood," as yet, has not been elected a member even of the select society of standard names, and I have a nice big blackball handy for it when the time arrives. It may be a trade name, a government name or anybody's name; but common name it certainly is not. A lady of my acquaintance once had thrust upon her the honour of having a worm named after her. But delicately, in Latin. This species or genus of worm is so rare that it can hardly be expected to rejoice in a common name; and it would be a hardy helminthologist who'd dare propose rectifying the omission by instigating Garge to call it "Emily's worm." That would be common. Our old friend *Podocarpus falcata* has been known by the denizens of its natural habitat ever since its occupation as "falcate yellowwood," and the fact that the foliar characteristic implied by the name is not indicated in its revised bontanic epithet is no valid reason for confounding its god-parents. The woodcutters' resentment at being informed that falcate yellowwood is not, as they fondly believed, falcate yellowwood, may well be imagined, and even shared. Common names are names that convey definite conceptions to common men. They are used effectively because, like current speech in any language, they derive from common use by common men. Specialists communicate quite effectively amongst themselves in a language of their own, and are entitled to revise what is their own to their hearts' content; but they have no authority whatsoever over the language of common men. They may record, not dictate. A rose by any other name might smell as sweet; but to ask for one under any other may result in being proffered a scentless cauliflower. "No, Bobby!"* as Mr. A. P. Herbert might say, "Stamp on it!"

But there are other interlopers in the list. I find, for instance, "pinaster pine" for *Pinus pinaster,* a species that all my life I have known as "cluster pine." "Maritime pine" is another good old name for it; but to call it "pinaster pine" is to give it a name that is scarcer than its uncommon, or botanic, name.

It is to be hoped that when a system of standard nomenclature for woods grown in South Africa is ultimately adopted, that faithful servant, the common name, will not be shouldered aside altogether in favour of a soulless echo of its botanical equivalent. If culture have a local habitation,

*The Editor does not answer to the name of "Bobby."

the names of natural objects that enter into common speech are surely near the heart of it.

A contributor in the last issue of our Journal claims that "a standard nomenclature is very necessary," but refrains from saying why. These "very necessaries" are as a rule quite unconsidered, and deserve consignment to Mr. Herbert's displeasure. For the life of me, I do not see why a standard name is even ordinarily necessary. Common Man, having got slightly confused by Nature's prodigality, the specialist steps in to his aid, and tells him that if he will adhere to a carefully thought-out scheme devised by him for the pinning down of a particular tree, animal, bird, fish or other natural object, his confusion, even in the face of Nature's ever increasing prolificacy, will end. Some common men try to keep step with the specialist, and some of these find that his system works. Others complain that the specialist's names are difficult to pronounce, and still more difficult to spell and remember, and forthwith relapse into a state of arcadian barbarism. The specialist, in despair, cries "halt! all is not yet lost. We can effect a compromise. You may still use your common language. I'll use my own scientific one. But we'll concoct a third, in which we shall communicate with each other. In this, our standard language, we shall use your vocabulary, but there must be no alternative names for one and the same object; and, to ensure that a specific object is indicated by a name from your vocabulary, you must check it up against my name for it. In other words you hang your conceptions on my pegs." "Thanks," I can imagine some of our stouter common men replying. "But we'd still have the same difficulty as before in identifying your pegs. And what about the common men of Bugongo? Let's leave Bad alone!"

Yours faithfully,

MONNIKER.

RESENSIES—REVIEWS

PINE NUTRITION. By *S. L. Kessell* and *T. N. Stoate*. Forests Dept. Bulletin No. 50. Western Australia, 1938.

FUSED NEEDLE DISEASE AND ITS RELATION TO THE NUTRITION OF PINUS. By *H. E. Young*. Queensland Forest Service, Bulletin No. 13, July, 1940.

These two papers represent the results of research into closely allied problems in two different States in the Australian Commonwealth, and the findings of the respective authors have so much in common that it seems suitable to review them together.

The unthrifty growth of pines on marginal sites, manifesting itself in foliage abnormalities such as rosetting and fused needle, death of the leading shoot and sometimes complete stagnation, is well known to foresters in certain regions in the Union, and the results obtained in the investigation of this problem in Australia should prove of value to foresters in this country.

The authors of the first-mentioned paper, investigating the causes of unthrifty growth of *P. radiata* (*P. insignis*) and *P. pinaster* on the poor coastal sands of Western Australia, followed up the theory that soil fertility was a major causal factor of unhealthy growth. A chemical analysis of soils from healthy and unhealthy stands revealed a close correlation between phosphate (P_2O_5) content and healthy growth and the authors suggest that, under Western Australian conditions, a minimum of 400 parts per million and 150 p.p.m. of phosphate in the surface soil is necessary to the healthy growth of *P. radiata* and *P. pinaster* respectively.

The authors were unable to correlate unhealthy growth with a deficiency in any of the other major soil elements.

Of the minor soil elements, zinc and nickel in solution sprayed on the foliage, and zinc in salt form added to the soil, produced a remarkable response in vigour in trees affected with rosetting and dead tops on certain sites, and spraying with a $1\frac{1}{4}$ to $2\frac{1}{2}$ per cent. solution of commercial zinc sulphate has now been adopted as standard practice in affected stands of both species on these sites.

Certain stands have not responded to zinc sprays, but in these, as on many of the poorest sites, the application of a superphosphate dressing has given excellent results and it is now standard practice to apply 1 to 2 cwts. per acre of superphosphate to *P. pinaster* at the time of planting on the coastal sands.

Superphosphate applied close to the base of the tree is stated to give no side effect for some years. This is rather remarkable in view of the normal presence of feeding rootlets at the ends of the main lateral roots in pines and the fact that the radius of root spread often exceeds the height of the tree in the young stages, especially in sandy soils, as evidenced by the reported side effect obtained with zinc sulphate.

The authors record that there appears to be no correlation of soil moisture factors with unhealthiness, and that soil cultivation causes only

a temporary improvement in health. Shelter given by cover crops of *Acacia pycnantha* and natural Eucalypt coppice has resulted in improved growth of pines, and pines planted on old pastures or on sites where grasses flourish have so far shown no signs of ill-health.

The possibility of mycorrhizal relationships being concerned in the problem was considered but was not followed up owing to lack of facilities. In view of the Queensland findings this factor would appear well worth investigation.

The author of the second paper, studying the causes of growth abnormalities in *Pinus taeda* and *P. caribaea* in Queensland, also approached the problem from the nutritional aspect after detailed experimentation had eliminated virus disease, mechanical injury, climatic factors and physical soil factors as possible causes of the ill-health of the trees.

Following up the work of the Western Australian authors the influence of the phosphate content of the soil on the health of the pines was confirmed and the author suggests that a minimum of 135 p.p.m. and 110 p.p.m. total phosphate content is necessary to the healthy growth of *P. taeda* and *P. caribaea* respectively under Queensland conditions.

Investigating the influence of the minor soil elements on fused needle disease the author reports negative results with zinc and other elements, but shows that a definite reduction in the incidence of the disease was obtained with copper applied broadcast to the soil in the sulphate form. He suggests, however, that any stimulus resulting from the treatment of pines with salts of the minor elements may be due to an increase in chlorophyll rather than to an actual deficiency in the element concerned. The possibility of minor elements exerting an indirect influence as catalysts in soil oxidation-reduction processes is also discussed.

At an early stage in the investigation the author observed the influence of suitable humus in the surface soil on the healthy development of pines and he deserves great credit for the research which established the importance of a constant supply of fresh humus and of the mycorhizal relationship to the healthy metabolism of the Southern pines in Queensland.

The author propounds the interesting theory that mycorrhizal fungi contribute largely towards the carbohydrate requirements of the pines through the root system. This is in direct contradiction to the generally accepted theory that the fungal symbiont obtains its carbohydrate supply from its mycotrophic partner but is well supported by experimental results and by work in other fields. The theory fits in well with the established importance of forest litter to a healthy mycorrhizal relationship since sugar is the first breakdown product of cellulose and it is well known that mycorrhizal fungi are able to break down organic matter into simple sugars. It should be noted that the author does not discount the generally accepted hypothesis of nitrogen supply to mycotrophic plants by mycorrhiza but proposes carbohydrate supply as an additional function of the fungal symbiont.

The relationship of phosphate status to the carbohydrate hypothesis is also discussed and the author suggests that added superphosphate may serve a fourfold purpose as follows:—

(1) By aiding decomposition of plant detritus and thus increasing the supply of humic material available to soil micro-organisms.
(2) By increasing the production and excretion by the higher plant

of phosphatides which are essential to the metabolism of mycorrhizal fungi.

(3) By a direct stimulus to the growth of mycorrhizal fungi.

(4) By a direct manurial effect on the higher plant.

All the author's deductions are supported by experimental results and it is of interest to note that the reviewer has observed fused needle symptoms on a site in the Western Cape from which the natural vegetation had been removed prior to planting and had not reappeared by the end of the second year as is usually the case.

The findings of the Western Australian authors in regard to the healthy growth of pines on sites with a good ground cover also tend to support the author's deductions. The results obtained in both cases appear to indicate that growth abnormalities will usually occur on sites low in phosphate content and devoid of a good herbaceous ground cover, and that they tend to persist until canopy closure takes place or until a suitable ground flora develops. These findings make a strong argument in favour of the policy, recently adopted in the Union, of direct planting in undisturbed natural vegetation.

The paper contains an excellent description of the morphology and physiology of mycorrhiza and a useful summary of research in the field of mycotrophy up to the present time.

The study of both these papers is strongly recommended to foresters, especially in those areas in the Union in which pines exhibit abnormal foliage conditions and unthrifty growth.

S.P.S.

EVIDENCES OF RACIAL INFLUENCES IN A 25 YEAR TEST OF PONDEROSA PINE. By *R. H. Weidman*. Journ. Agric. Research Vol. 59 No. 12, 1939.

Stocks of *Pinus ponderosa* from 20 localities with a wide range in altitude and climatic types were planted in adjacent plots in the Kaniksu Forest, U.S.A., between 1911 and 1916. The paper under review reports the results of the trial as at 20 years after planting out.

At this early stage of the test the author wisely makes only tentative deductions as to the heritability of certain characters in which marked differences occur. His conclusions regarding the heritability of the number of needles to the fascicle, the general growth habit and the relative rates of growth of the progenies seem amply justified by the available evidence. The evidence of heritability of needle length seems to be not entirely conclusive notably in the case of the Helena and Custer stocks though the discrepancies in these cases may be due to chance errors in sampling and the greater majority of the off-spring show remarkable consistency in mean needle length with that of their parents.

One of the most interesting features of the test is the fact that both the Lolo and Bitterroot 4,000 have so far proved markedly superior to the local Kaniksu stock in vigour and hardiness. The temperature extremes of all three localities are approximately the same and needles from all three localities show similarly thickened cell walls in the hypoderm tissue. Both the Lolo and the Bitterroot areas however have a considerably lower rainfall than that of the Kaniksu area and in addition their precipitation effectiveness indices are markedly less, which may be a reason for the superior vigour of the Lolo and Bitterroot trees up to this age at Kaniksu.

From the available evidence the author deduces the existence of

four apparently distinct races of *P. ponderosa* with well marked individual characteristics in respect of number of needles to the fascicle, needle length, degree of thickening in the cell walls of the hypoderm, vigour and frost hardiness. A further report at a later stage in the growth of these progenies will be of great interest and should confirm many of the present necessarily tentative conclusions.

S.P.S.

INFLUENCE OF VEGETATION AND WATERSHED TREATMENTS ON RUN-OFF SILTING AND STREAMFLOW. A Progress Report of Research Prepared by the Forest Service and Soil Conservation Service. U.S.A. Dept. of Agric. Misc. Publ. No. 397, 1940.

This report, written in semi-popular style, summarises results yielded by research undertaken by the United States Forest and Soil Conservation Services. A general account is given of the hydrological effects of vegetation and watershed treatments. Data yielded by many research projects are quoted to demonstrate the relative importance of the various processes in the hydrological cycle. Striking figures of run-off, silting and streamflow, together with excellent graphs, diagrams and photographs give the publication a high propaganda value. The report indicates the large amount of hydrological research which is being undertaken in the United States, and will, no doubt, stimulate general interest in this work.

Foresters will be particularly interested in measurements which demonstrate the effects of forests on infiltration, rainfall interception, evaporation, run-off, silting and streamflow. Thus P. B. Rowe has found in the pine region of the Sierras, that if the soil is covered with two inches of *Pinus ponderosa* litter, the run-off is 11.6 per cent. of 96.67 inches of rain, the seepage is 62.8 per cent. and evaporation 25.4. Where the soil is bare the run-off is increased to 34.2 per cent. seepage is 62.8 per cent. and evaporation 25.4. Where the soil is bare the run-off is increased to 34.2 per cent., seepage reduced to 30.4 and evaporation increased to 35.4. Very striking data to show how peak flows are reduced by forest cover are quoted from studies made in the Copper Basin, Tennessee. Two catchments under forest yielded maximum rates of flow of 30 and 56 cusecs per square mile respectively. Catchments under incomplete broomsedge cover yielded 832 and 900 cusecs per square mile, and catchments denuded yielded 1,263 and 1,434 cusecs per square mile. Many other equally significant results are given in the report.

Investigators in this field will miss descriptions of the experimental methods used. In some cases reference is made to publications in which these have been given in detail, but many of the projects have apparently never been described in print. Rainfall interception figures, for example, will have to be accepted with reserve until the technique of sampling direct penetration, drip and stem run-off, is known. It is stated that paired stations inside and outside the forest were used in these investigations. This method is not entirely sound, however, because it assumes that the rain over the forest is the same as the rain at a point some distance away from it, and, because the errors in the records of the more exposed rain gauges outside the forest—caused by wind eddies over the funnels—are usually not taken into account. The data given are, however, probably the most reliable which are available to-day, and the report is recommended

to all who wish to inform themselves about hydrological processes in general, and about research which is being done on this subject in the United States of America.

C.L.W.

TRANSVAAL CHAMBER OF MINES. TIMBER RESEARCH LABORATORY. ANNUAL REPORT 1939, pp. 23. Johannesburg.

The preservation of mining timber on the Witwatersrand is a highly specialised branch of the wood preserving industry. Though conditions for decay underground are exceptionally favourable, the useful life required is relatively short. Special preservatives are used and the time of pressure application is only a fraction of that commonly used in timber impregnation. It is stated in the report under review that the cost of treatment is only 1¼d. per cubic foot, which represents an increase of only 8 per cent. above the cost of the timber and increases its life by 400 per cent.

In 1939, £2,500,000 was spent on timber by the mining industry and about half of this, equivalent to 16 million cubic feet, was treated. The cost of treatment was less than £100,000 and this expenditure resulted in a saving which we can compute at over £3,000,000. The value of the work carried out at the Laboratory, which laid the foundation for the preservation of mining timber, is thus amply demonstrated. Mr. Bowen's latest report shows that improvements are being continually sought after. Specific problems which have been investigated include means to increase the absorption of preservative in a given time. Different aspects of this question have been investigated but little attention appears to have been given to the simple expedient of increasing the concentration of the treating solution. Interesting work has been carried out on the relative strength of treated and untreated mine supports and work of the greatest importance has been done in connection with underground fires, the position being summarised as follows: "The greatest security against underground fires is sound timber. As treatment prevents decay for considerable periods it is considered that the treatment of timber with preservatives is an insurance against fire."

Behind the scenes, systematic mycology receives considerable attention and the importance of this phase of the work is emphasised by the consultant, Mrs. R. Brown, in an interesting introductory report.

P.J.A.L.

SOIL CONSERVATION. BY *Hugh Hammond Bennett*. London, McGraw-Hill. 1939. 40s.

These two words are the simple title to a volume of 993 pages by Hugh Hammond Bennett, Chief of the Soil Conservation Service in the United States of America. No one is better qualified than the author to place on record what is being done to cope with this vital subject and later on it will no doubt become apparent how well he has done it.

In a short but tense preface the history of the white man's sojourn on the American Continent is portrayed. Man and beast wrought such havoc in forest and grassland that soil erosion very seriously threatened the existence of the nation. The awakening when it came resulted eventually in the formation of the Soil Conservation Service to rehabilitate the country. The book is divided into two parts. Part 1 deals with the

problem of soil erosion and the principles involved, while Part 2 is devoted mainly to soil conservation methods.

Under the heading "The Problem in the United States" the conditions which existed in the virgin land before the advent of the settlers are given, and it is shown how water from the rains moved slowly over the ground surface, due to the dense cover of vegetation, and it is pointed out that the rivers in those days ran clear. In fact, the top soil was kept in equilibrium by nature. It was not removed faster than it was built up. As soon as the march of occupation began from east to west, the great depletion of natural resources started. These included the wildlife, the vegetation and the soil; and rightly is it stressed that the potential wealth and living standard of any nation depend ultimately on its store of natural resources. Soil is regarded as the most unstable of all major natural resources, and the action of wind and water on soil denuded of vegetation is described. It is pointed out that once soil is stripped of its protective cover of vegetation, wind and water can remove it a thousand times faster than before. This rapid removal of soil is what is known as *Soil Erosion*. In the United States it is estimated that approximately 282 million acres have been ruined or seriously impaired through soil erosion. From another 775 million acres it is stated that erosion has stripped away very considerable proportions of the essential topsoil. As soil is an indispensable resource the gravity of the situation is so great because of the irreplacable nature of soil. To cover an acre of land to a depth of 7 inches one thousand tons of soil are required. The slow growth of soil is stressed, and it is computed that under the most favourable conditions, it takes nature, working under a good cover of vegetation, anywhere from 300 to 1,000 years or more to build up one single inch of topsoil. Thus, if 7 inches of topsoil are allowed to wash away, nature's work over at least 2,000 to 7,000 years is wasted. This may occur with one single downpour, if the land has been maltreated.

The annual losses of soil are enormous. It is estimated that at least three thousand million tons of soil are washed out of the fields and pastures of America every year. From the Mississippi alone it is held that about 730 million tons of solid matter are washed into the Gulf of Mexico annually. Based on these losses, the losses of plant food every year are computed, and it is stated that erosion removes sixty times as much available and potential plant food as is returned to the soil by various forms of commercial fertilizers.

The indirect damage of erosion is also rightly stressed. In particular it is pointed out that as erosion strips away the absorptive top layers of soil, rainwater encounters great difficulty in penetrating the less permeable layers lying below. Thus in many parts of the country the effects of drought on plant life have been intensified by soil removal.

Costs of erosion to the country are given, but these do not include huge losses due to (1) clogging of great reservoirs and shoaling of stream channels; (2) the abandonment of irrigated areas; (3) the abandonment of large agricultural areas; (4) the devastation of large western grazing areas; and (5) the disapparance of rural communities and their transfer to relief rolls or to new means of livelihood.

The conclusion is reached that Americans as a whole have never learned to love the land and to regard it as an enduring resource, but that they have only looked upon it as a field for exploitation and as a source of quick financial return.

In reviewing the part played by government in the programme of soil conservation emphasis is laid on the fact that "the soil must be conserved ultimately by those who till the land and live by its products."

Under the heading "Erosion and Civilisation" a comprehensive survey is given of the history of agriculture in Mesopotamia, the eastern Mediterranean countries, Greece, Italy, North Africa, Persia, England, Scotland, the Palatinate and the Americas and in each case it is shown that soil erosion is an integral part of its agricultural history.

The results of erosion in the United States are discussed at length and after showing that more than half of its total land area has been affected by erosion, its effects on the water supplies and on the economic and social life of the country are given. From this survey the conclusion is reached that soil erosion if uncontrolled, "impoverishes not only the land but those who live on and by the land, as well as communities and urban areas dependent in part or entirely on the welfare of the farmer."

In discussing erosion two main types are distinguished: normal erosion and accelerated erosion. In the former case soil is built up and maintained in a state which is favourable to the growth of most plants, while in the latter case soil is broken down and wasted. Erosion by water and by wind is described in detail and all the different types known are quoted and explained.

A very full chapter is devoted to rates of erosion and run-off and a number of tables and graphs are given to show the soil and water losses under many varying conditions. It is shown that these losses from virgin forest and grassland are so small that soil probably builds up from below as quickly as it is removed from the surface. The effect of biological forms on soil and water conservation is also discussed and its importance emphasised.

In dealing with climate and soil erosion the need for more instrumental data is emphasised and the desirability for more stations to secure the very necessary climatic records is stressed. The importance of knowing the *effective precipitation* of any area in dealing with erosion studies and erosion control is brought out and Thornthwaite's classification of climatic types is recommended for use. The necessity of having detailed information about rainstorm types is also rightly insisted upon, and it is concluded that the climatic zone of greatest danger as regards erosion lies on the drier margins of semiarid climate and within arid regions.

Water intake in relation to run-off is explained clearly and at some length and the effects of tillage, of organic matter and of turbidity of surface water on infiltration are separately summarised. In quoting the important part played by plant roots in increasing underground penetration it is shown that a single wild-oat plant nearly three months old may possess a root system totalling 54 miles in length. Increased penetration of rainfall results in reduction of run-off and erosion, and in increase of available water for plant growth.

An illuminating chapter deals with the relation of erosion to crop yields in the United States and the view is expressed that "erosion has thwarted much of the stupendous efforts to increase the acreage yield of the crop in the United States." It is remarked as significant that in spite of all the breeding work done on maize with regard to better varieties, in spite of improved crop rotations and greater use of fertilizers, and in spite of every form of agricultural education the nation wide yield per acre of maize has not increased to any important extent. Comparative figures

and tables are given of the yields of the more important crops over the past two and three decades, and these support the view regarding the decline of the yields of these crops. The vegetation changes brought about by erosion over millions of acres of grazing and farm lands throughout the States are described with clearness and the great dangers which underlie all this sudden change and their implications to the economic welfare of the nation are stressed again and again. The pictures painted of the spread of thickets of persimmon and sassafras and other weeds over eroded areas recall to mind the very similar state of affairs which is occurring in South Africa today over much of our best farming and ranching land, where thorn bush and thorn thicket have become more than a serious menace.

The chapter on sedimentation depicts the enormous damage which is being done to those places where the debris from erosion is being deposited viz.: rivers, reservoirs, irrigation works and flood plains. Here again the silting of our South African reservoirs and rivers and the incease of flood hazard tells the same tale and points the warning finger.

In discussing geology and soil erosion emphasis is laid upon the fact that nature employs the engineering method of slope reduction and the vegetative method of surface protection by appropriate plant cover in her erosion control. The important part played by insects in causing erosion through the destruction of the vegetation cover is briefly outlined, and in particular, the grasshopper is quoted as an agent of great destruction. In Sonth Africa, the part played by termites in this connection is only too well-known.

The second part of the book outlines the events and steps which led up to the establishment of the Soil Conservation Service and to the National programme of soil conservation. Its broad objectives are given, and the methods that are being employed on the different types of erosion in the many parts of the United States for its control are graphically illustrated and described.

Of particular interest to readers of this journal will be the chapter dealing with the place of forestry in soil and water conservation.

The book is clearly printed, is well illustrated throughout with sharp and vivid photographs, and the subject matter is very much to the point.

The book is a credit to the capacity and industry of its author, a further monument of achievement to the United States Department of Agriculture and the nation behind it, and a fund of valuable information to all those who seek advice on this worldwide problem.

I.B.P.E.

UITGAWES ONTVANG
PUBLICATIONS RECEIVED

Ontvangs van die volgende uitgawes word met dank erken:

Receipt of the following publications is acknowledged with thanks:

ANNUAL REPORT: See under JAARVERSLAE, below.

AUSTRALIAN FORESTRY. Vol. v. No. 2. December, 1940.

CONTRIBUTIONS FROM THE NEW SOUTH WALES NATIONAL HERBARIUM. Vol. 1. No. 3. January, 1941. A Revision of the Australian Species of *Agrostis* Linn. By Joyce W. Vickery, M.Sc.

EMPIRE FORESTRY JOURNAL, THE. Vol 19. No. 2, 1940.

FORESTRY, THE JOURNAL OF THE SOCIETY OF FORESTERS OF GREAT BRITAIN. Vol. xiv. No. 2, 1940.

FORESTS AND EROSION. By Professor E. P. Stebbing. Reprinted from the *Journal of the Royal African Society*, January, 1941.

JAARVERSLAE:

Nyassaland Protectorate. Forest Department for the year ended 31st December, 1940.

Unie van Suid-Afrika. Afdeling Bosbou vir die jaar geëindig 31 Maart, 1940.

Union of South Africa. Division of Forestry for the year ended 31st March, 1940.

MALAYAN FORESTER, THE. Vol. x. No. 1. January, 1941.

SCOTTISH FORESTRY JOURNAL, THE. Vol. 54. Pt. 2, October, 1940.

The

Journal of the South African Forestry Association

October

PUBLISHED BY THE ASSOCIATION
April and October

Die

Tydskrif van die Suid-Afrikaanse Bosbouvereniging

Oktober

UITGEGEE DEUR DIE VERENIGING
April en Oktober

No. 7. 1941
PRETORIA
6/-

SOUTH AFRICAN FORESTRY ASSOCIATION.

Patron:

HIS EXCELLENCY THE GOVERNOR-GENERAL,
THE RIGHT HON. SIR PATRICK DUNCAN, G.C.M.G., K.C.

President:

COLONEL THE HONOURABLE DENEYS REITZ, M.P.

Vice-Presidents:

COLONEL THE HONOURABLE W. R. COLLINS, M.P., D.T.D., D.S.O.
HANS MERENSKY, DR.ING.H.C., D.Sc.
H. J. VAN DER BIJL, PH.D., D.Sc., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF,
P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.
C. E. LEGAT, C.B.E., B.Sc.
J. HUNT HOLLEY.
T. M. MACKENZIE.

OFFICERS:

Chairman: J. D. KEET, DIP.FOR., M.Sc. (HON.)
Vice-Chairman: H. A. READ, F.S.A.A.
Hon. Editor: J. M. TURNBULL, DIP.FOR.
Hon. Secretary-Treasurer: P. J. A. LOSEBY, B.Sc., M.A.

Executive Committee:

J. D. KEET, DIP.FOR., M.Sc. (HON.), (*Chairman*)
H. A. READ, F.S.A.A. (*Vice-Chairman*)
I. J. CRAIB, M.F., PH.D.
H. A. LORENTZ, LL.D.
PROFESSOR JOHN F. V. PHILLIPS, D.Sc., F.R.S.E., F.L.S.
J. M. TURNBULL, DIP.FOR. (*Hon. Editor*)
P. J. A. LOSEBY, B.Sc., M.A. (*Hon. Sec.-Treas.*)

ANNUAL REPORT FOR THE YEAR ENDED MAY 31ST, 1941.

Satisfactory progress was made by the Association during the past year.

The Association was honoured by having Messrs. T. M. Mackenzie and J. Hunt Holley accept office as Vice-Presidents.

The membership of the Association and permanent subscribers to the Journal at the close of the year were as follows :—

Life Members	6	
Full Members	172	
Associate Members	162	
81 Affiliated Members having	89	nominees
Honorary Officers and Members	9	
Subscribers	22	
Total	460	

Eighty-five new members were enrolled by the Association and 23 members resigned, resulting in a net increase of 62 members. Under existing circumstances this increase must be regarded as highly satisfactory.

The accounts submitted with this report show that the income for the year was £578 6s. 8d. and the expenditure £480 6s. 11d., leaving an excess of income over expenditure of £97 19s. 9d. This compares favourably with a similar balance of £10 18s. 4d. for 1939-40 and £23 5s. 6d. for 1938-39. If to this total is added the amount of £115 received in the forms of donations during 1939-40, it will be seen that the Association has a balance of £247 3s. 7d. in hand.

Two numbers of the Journal were published during the year and continued to receive favourable notices both at home and overseas. The sizes of both these issues were normal despite the numbers of potential contributors to the Journal who are now on active military service.

The Association gratefully recognises its indebtedness to the Executive Committee for managing its affairs during the past year; also to the Editorial Committee for turning out two good numbers of the Journal; to the Hon. Editor, Mr. J. M. Turnbull, who is chiefly responsible for the high standard maintained by the Journal; and to the Hon. Secretary-Treasurer, Dr. I. J. Craib, who, with the able assistance of Mr. E. E. M. Loock, had to render the usual amount of voluntary work, and through whose personal efforts the Association gained a considerable acquisition to its membership list. We again wish to thank all those who sent contributions to the Journal.

Mr. A. N. White again consented to act as Honorary Auditor and his services are gratefully acknowledged.

(Sgd.) J. D. KEET,
Chairman.
29th August, 1941.

MINUTES OF THE THIRD ANNUAL GENERAL MEETING

HELD AT SOMERSET HOUSE, VERMEULEN STREET, PRETORIA, AT 8.30 P.M. ON AUGUST, 29TH, 1941.

Attendance : Twenty-five members were present.

1. The Hon. Secretary-Treasurer read the notice convening the meeting.

2. The Chairman conveyed the apologies of Prof. John F. V. Phillips for his inability to attend the meeting. He thanked members for their continued support and expressed his personal appreciation of the work of the Executive Committee and Editorial Committee, more especially of the Hon. Editor, Mr. Turnbull, and the Hon. Secretary-Treasurer, Dr. Craib, assisted by Mr. Loock. Special thanks were due to Mr. Watt, who deputised for Mr. Maggs on the Executive Committee, and to all those who contributed articles to the Journal of the Association. He referred to the large number of members who were on active service and in the name of the Association wished them good luck and a safe return.

The Chairman then referred to the effects of the war on forestry and the timber trade in South Africa. He forecasted a shortage of overseas supplies of building timber and an increase in the demand for wattle products after the war. Unless the war was protracted beyond present expectations, there appeared to be good prospects of the local timber industry ameliorating the difficult conditions which might ensue. Sawmilling plants had up to the present been supplied almost entirely from intermediate yields, and, though the State was prepared to resort in emergency to clear-felling in immature stands, no such necessity had as yet arisen. The Expansion of the sawmilling industry was hampered by difficulty in obtaining machinery, but this disability would be removed after the war when increased activities would lead probably to greater opportunities for employment.

The present emergency focussed attention on the many advantages to be gained by countries possessing internal timber resources, and lessons learned after the last war had redounded through a State policy of accelerated afforestation to the benefit of South Africa to-day. This policy had fully justified itself, and maintenance in permanent productiveness of sawmills established during the present war should be a further incentive both to the State and to private owners to continue afforestation.

In regard to indigenous forests, the Association had been able to give a lead to public opinion by advocating their conservation, and an increasing sense of public duty in conserving the natural resources and amenities of the country was hoped for.

Although there might be anxiety that owners of private plantations might be induced by pressing demands to dispose of their crops without taking adequate steps to ensure regeneration, this was less dangerous in the case of short rotation crops such as eucalypts and wattles, regeneration of which was easily achieved and for which examples of the best practice were often locally available. The position was different in the case of coniferous crops which might mature only in a future generation. It was to be hoped that present circumstances would act as sufficient inducement to growers to regenerate their crops. The chief species would usually regenerate themselves naturally from seed, provided the correct practice was followed. The State was always prepared to assist private growers in an advisory capacity in this as well as in other aspects of forestry. Though private forests and plantations could be proclaimed under the new Act as protected forests or plantations, the State preferred to act in co-operation with private owners in endeavouring to ensure that the best silvicultural practice was followed.

While there had as yet been no need for the Association to give any definite lead in the forest policy of the country, it could have fulfilled a useful function under present conditions by publishing suitable articles on the conversion of timber. Unfortunately, shortage of staff and increased activities in the Division of Forestry and other spheres had militated against this, but it was to be hoped that articles of this nature might still be forthcoming.

The Chairman referred to the recently formed Association of Sawmillers, to the formation of an Institute for Leather and Tanning Research at Grahamstown, and to efforts by the South African Wattle Growers' Union to establish a Research Institute for the wattle industry. He welcomed these movements and hoped for their success.

In conclusion, the Chairman referred to the effect of the war on the local timber industry. The Emergency Regulations had brought some stability in prices and the Government had assurance that there was no profiteering on imported timbers. Prices of local timbers were generally less than those of the imported, but the latter had advanced far beyond pre-war levels, and difficulty was being experienced in meeting the demands of the market. Sawmillers were advised to allocate their profits to capital reduction and plant improvement in order to consolidate their position for the future.

All who had concern for the future of the industry were anxious to see that local timbers brought on to the market at the present time should be well manufactured and seasoned. Any bad reputation created for local timbers would certainly persist to their detriment under post-war conditions.

3. The minutes of the Second Annual General Meeting of the Association, having been published in the fifth issue of the Journal, were taken as read. The minutes were confirmed and approved.

4. Arising out of the minute instructing the Executive Committee on ways and means of popularising the Association, the Chairman reported that a circular letter had been addressed to Conservators of Forests to obtain their views on the possible establishment of regional committees. Though the proposal met with support, the general opinion which had been expressed was that the present time was inopportune to proceed with this project.

The Hon. Secretary-Treasurer reported that in an effort to increase membership of the Association, he had sent circulars to over 400 municipalities, clubs, libraries, sawmilling firms and timber growers. This had resulted in the acquisition of 70 new members. The possibility of producing a book of tree species, comparable with those of flowers and fauna put out by the United Tobacco Company, was under consideration by the Executive Committee.

The Chairman called for further suggestions for increasing the membership of the Association and some discussion ensued.

Mr. O'Connor wished individual members stationed at outside centres to be appointed as propaganda officers.

Mr. Brunswick, of the Pretoria Municipality, suggested that the public should be interested in ornamental as well as timber trees, especially native species, and mentioned experiments in the local municipal nurseries with indigenous trees for street ornamentation. He complained from the public's viewpoint on the difficulty in obtaining seeds of indigenous trees and suggested that articles should be published on the sowing and raising of such trees. He put forward the suggestion that the Association should co-operate with the Pretoria Horticultural Society and the Association of Superintendents of Public Parks and Gardens in matters of this nature.

The Chairman replied that the Division of Forestry was endeavouring to extend its nursery stocks of indigenous species, but could not keep pace with the demand. He also commented on the public's reaction in several instances in favour of planting indigenous trees rather than exotics.

Mr. Read recalled disheartening results of previous efforts to interest other municipalities, and Mr. Brunswick suggested that more fruitful action might be taken through the Association of Superintendents of Public Parks and Gardens (Secretary: Mr. McInerny, Roodepoort).

Mr. du Preez was of the opinion that copies of Dr. Craib's circulars should be sent to District Forest Officers, who might be able to engender local interest by these means.

There were suggestions in favour of the publication of short articles on individual native trees in the form of a series.

Mr. Turnbull was disappointed with the replies received to the Chairman's letter to Conservators and expressed the opinion that if one Regional Committee could be inaugurated to show the way, others would follow. He felt that Pretoria was well situated to give the required lead. Details of the functions of such committees should be outlined. Mr. O'Connor suggested that the war was being made an unjustified excuse for inaction. The organisations should be similar to local farmers' associations.

The Chairman stated that he was prepared to re-open the matter with the Conservators.

Mr. Read referred to the paucity of members in the ranks of legislative bodies and pressed for renewed efforts to recruit members amongst Senators, Members of Parliament and Provincial Councillors.

Dr. Craib suggested that the Association might increase in popularity if more articles were published in the Journal which were of direct practical benefit to its readers.

5. The Hon. Secretary-Treasurer then read the Annual Report of the Executive Committee and presented the Financial Statement. On the motion of Mr. O'Connor, seconded by Mr. Turnbull, these were adopted.

6. The Chairman announced the result of the ballot for the election of new officers of the Association, as follows :—

Member of the Executive Committee : Dr. I. J. Craib.
Hon. Secretary-Treasurer : Mr. P. J. A. Loseby.

7. A vote of thanks to the retiring Hon. Secretary-Treasurer, Dr. Craib, was proposed by Mr. Turnbull, seconded by Mr. O'Connor, and carried with acclamation.

8. Mr. Read commended, for consideration by members, preparations for the aftermath of the war, suggesting that more particular attention might be paid to the utilisation of waste timber for such purposes as the manufacture of cellulose and fibre board. He also recommended the more extensive planting of gums, especially *Eucalyptus saligna*, and criticised the Division of Forestry for its policy in converting gum plantations to pine species. Mr. Eckbo supported this suggestion, saying that forest products research had found suitable uses for gum timbers and remarking that *Euc. saligna* probably produces the greatest amount of cellulose per acre of all tree species. Existing gum plantations should be retained and the shortage of softwoods made up by planting new areas.

The Chairman welcomed these remarks. He stated that it was Government policy to leave the growing of mining timber to private enterprise and the problem of the disposal of thinnings was therefore an obstacle in the way of further extension of gum plantations. Much of the conversion that was taking place was of species of eucalypt which had proved unsuitable. He agreed with the observations of previous speakers in regard to *Euc. saligna* and said that the Government was alive to the need for exploring the possibilities of further developing the resources of this species.

9. On a motion by Mr. Watt, seconded by Mr. King, a vote of thanks to the Hon. Editor, Mr. Turnbull, was carried unanimously.

10. With a unanimous vote of thanks to the Chair, the meeting closed at 10.20 p.m.

(Sgd.) P. J. A. LOSEBY,
Hon. Secretary-Treasurer.
29th August, 1941.

SOUTH AFRICAN

INCOME AND EXPENDITURE ACCOUNT

EXPENDITURE

To Publication of Journal	£355 12 9		
Add amount outstanding	190 9 9		
	£546 2 6		
Less amount due in 1939/40	157 6 2	£388 16 4	
To Printing of Reprints		58 12 0	
To Stationery and Office Sundries		12 4 0	
To Postage Stamps and Postal Charges		10 7 0	
To Bank Commission and Discount on Bills		6 2 10	
To Bank Charges		1 6 3	
To Miscellaneous Expenses		2 18 6	
To Balance (Surplus of Income over Expenditure for 1940/41)		97 19 9	
		£578 6 8	

BALANCE SHEET AS

LIABILITIES

Subscriptions Paid in Advance—		
Life Members	£76 13 0	
Other Members	14 8 0	£91 1 0
Journals Paid for in Advance		1 1 0
Reprints Paid for in Advance		3 2 0
Sundry Creditors		190 9 9
Capital Account—		
Surplus for 1938/39	£23 5 6	
Surplus for 1939/40	125 18 4	
Surplus for 1940/41	97 19 9	247 3 7
		£532 17 4

I hereby certify that I have examined the books and accounts of the Association and Balance Sheet correctly reflect the Association's position.

FORESTRY ASSOCIATION

FOR THE YEAR ENDED 31ST MAY, 1941

INCOME

By Subscriptions—			
Life Members			£6 6 0
Other Members	£316 14 0		
Add Payments Previously Received	5 7 6		
	£322 1 6		
Less Arrear Payments	1 8 6		
	£320 13 0		
Less Advance Payments	11 15 6		
	£308 17 6		
Add Subscriptions Outstanding	25 2 6		334 0 0
By Sale of Journals	£148 9 3		
Add Payments Previously Received	2 3 6		
	£150 12 9		
Less Arrear Payments	40 10 6		
	£110 2 3		
Less Advance Payments	1 1 0		
	£109 1 3		
Add Amount Outstanding	4 8 6		113 9 9
By Sale of Reprints	£85 6 3		
Less Arrear Payments	39 8 3		
	£45 18 0		
Less Advance Payments	3 2 0		
	£42 16 0		
Add Amount Outstanding	58 13 6		101 9 6
By Advertisements	£23 11 6		
Less Arrear Payments	14 13 6		
	£8 18 0		
Add Amount Outstanding	12 3 8		21 1 8
By Commission on Cheques			1 19 9
			£578 6 8

AT 31ST MAY, 1941

ASSETS

Cash in Bank	£425 7 4		
Cash in Hand	1 11 6		£426 18 10
Sundry Debtors			80 16 0
Subscriptions in Arrear			25 2 6
			£532 17 4

South African Forestry Association and that the above Income and Expenditure

(Sgd.) A. N. WHITE.

27th August, 1941.

SUID-AFRIKAANSE BOSBOUVERENIGING.

Beskermheer:

SY EKSELLENSIE DIE GOEWERNEUR-GENERAAL,
DIE HOOGEDELAGBARE SIR PATRICK DUNCAN,
G.C.M.G., K.C.

President:

DIE EDELAGBARE KOLONEL DENEYS REITZ, L.V.

Vise-Presidente:

DIE EDELAGBARE KOLONEL W. R. COLLINS, L.V., D.T.D., D.S.O.

HANS MERENSKY, DR.ING.H.C., D.SC.

H. J. VAN DER BIJL, D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.

P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.

C. E. LEGAT, C.B.E., B.SC.

J. HUNT HOLLEY.

T. M. MACKENZIE.

AMPSDRAERS:

Voorsitter: J. D. KEET, DIP.FOR., M.SC. (ERE.)

Vise-Voorsitter: H. A. READ, F.S.A.A.

Ere Redakteur: J. M. TURNBULL, DIP.FOR.

Ere Sekretaris-Tesourier: P. J. A. LOSEBY, B.SC., M.A.

Uitvoerende Komitee:

J. D. KEET, DIP.FOR.,M.SC. (ERE.), (*Voorsitter*)

H. A. READ, F.S.A.A. (*Vise-Voorsitter*)

I. J. CRAIB, M.F., PH.D.

H. A. LORENTZ, LL.D.

PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.

J. M. TURNBULL, DIP.FOR. (*Ere Redakteur*)

P. J. A. LOSEBY, B.SC., M.A. (*Ere Sek.-Tes.*)

JAARVERSLAG VIR DIE JAAR GEËINDIG OP 31STE MEI, 1941

Die Vereniging het gedurende die afgelope jaar bevredigende vordering gemaak.

Mnre. T. M. Mackenzie en J. Hunt Holley het die Vereniging vereer deur die amp van Vise-President te aanvaar.

Mnr. J. D. Keet het as Voorsitter opgetree.

Die ledetal van die Vereniging en permanente intekenare tot die Tydskrif aan die end van die jaar was as volg :—

Lewenslange lede	6	
Volle lede	172	
Geassosieerde lede	162	
Geaffilieerde lede, 81, met	89	benoemde lede.
Ere ampsdraers en lede	9	
Intekenare	22	
Totaal	460	

Vyf-en-tagentig nuwe lede het by die Vereniging aangesluit, en 23 lede het bedank, met die gevolg dat die ledetal met 62 lede toegeneem het. Onder huidige omstandighede moet hierdie staat as bevredigend beskou word.

Die balans-staat wat saam met hierdie verslag ingedien word, toon aan dat die inkomste vir die jaar £578 6s. 8d. bedra het. Die uitgawe was £480 6s. 11d., sodat die inkomste £97 19s. 9d. meer as die uitgawe was, wat gunstig met 'n balans van £10 18s. 4d. vir 1939-40 en £23 5s. 6d. vir 1938-39 vergelyk kan word. Indien die som van £115 wat as skenkings gedurende 1939-40 ontvang is, hierby gevoeg word, sal dit opgemerk word dat die Vereniging 'n balans van £247 3s. 7d. in die bank het.

Gedurende die jaar is twee uitgawes van die Tydskrif gepubliseer en daar is weer beide plaaslik en oorsee baie oor opgemerk. Die grootte van beide hierdie uitgawes, ten spyte van die aantal potensiale medewerkers wat op militêre diens gebesig was, was normaal.

Die Vereniging is veel verskuldig aan sy Uitvoerende Komitee vir hul welwillende en bekwame medewerking gedurende die afgelope jaar; asook aan die Redaksie Komitee vir die voortbringing van twee goeie uitgawes van die Tydskrif; aan mnr. J. M. Turnbull, die Ere Redakteur, wat hoofsaaklik verantwoordelik was vir die hoë standaard wat deur die Tydskrif gehandhaaf is; en aan die Ere Sekretaris-Tesourier, dr. I. J. Craib, wat saam met die bevoegde hulp van mnr. E. E. M. Loock, die gewone hoeveelheid vrywillige werk moes lewer, en deur wie se personele pogings die Vereniging se ledetal aansienlik vermeerder het. Ons moet weer diegene bedank wat bydraes vir die Tydskrif gelewer het.

Mnr. A. N. White het weereens toegestem om as Ere Ouditeur op te tree, en sy dienste word met dank erken.

(Get.) J. D. KEET,
Voorsitter.

29 Augustus, 1941.

DERDE JAARLIKSE ALGEMENE VERGADERING

OM 8.30 N.M. OP 29 AUGUSTUS 1941, TE SOMERSET HOUSE, VERMEULENSTRAAT, PRETORIA, GEHOU.

Opkoms : Daar was 25 lede teenwoordig.

1. Mnr. J. D. M. Keet het as Voorsitter opgetree.
2. Die kennisgewing waarvolgens die vergadering byeengeroep is is voorgelees.
3. Die Voorsitter het die verontskuldiging van professor John F. V. Phillips vir sy onvermoë om die vergadering by te woon meegedeel. Hy het lede bedank vir hulle aanhoudende steun, en sy persoonlike waardering uitgespreek vir die werk wat die Uitvoerende en Redaksionele Komitees, byname die Ere Redakteur, mnr. J. Turnbull, en die Ere Sekretaris-Tesourier, dr. I. J. Craib, deur mnr. Loock behulp, uitgevoer het. Die vergadering is aan mnr. Watt baie dank verskuldig, wat

mnr. Maggs se plek op die Uitvoerende Komitee waargeneem het, asook aan al diegene wat artikels tot die Tydskrif bygedra het. Hy het verwys na die groot aantal lede wat op militêre diens was, en namens die vergadering het hy hulle geluk en 'n veilige terugkoms toegewens.

Die Voorsitter het toe na die uitwerking van die oorlog op bosbou en die houtnywerheid in Suid-Afrika verwys. Hy het 'n tekort van ingevoerde bouhout en 'n vermeerdering in die aanvrag vir wattelprodukte na die oorlog voorspel. Tensy die oorlog langer duur as wat vandag verwag word, skyn daar 'n goeie vooruitsig te wees dat die plaaslike houtnywerheid die moeilike omstandighede wat moontlik daarna sou volg, sou verbeter. Saagmeule is totnogtoe byna uitsluitlik uit tussenkomende opbrengs voorsien, en alhoewel die Staat in die geval van dringende nood gewillig sou wees om toevlug te neem aan platkap van onvolgroeide opstande bestaan daar sover geen noodsaaklikheid daarvoor nie. Die ontwikkeling van die saagmeulnywerheid is belemmer deur die moeilikheid wat bestaan om masjienerie te verkry. Hierdie moeilikheid sou egter na die oorlog verdwyn, en uitgebreide bedrywighede sou dan groter geleenthede vir werkgewing verskaf.

Die huidige aangeleenthede vestig aandag op die voordele wat deur bebosde lande geniet word, en hoe lesse wat na die laaste oorlog geleer is, deur middel van 'n nasionale beleid van versnelde bebossing, tot voordeel van Suid-Afrika uitgewerk het. Hierdie beleid is ten volle regverdig, en die handhawing in aanhoudende produksie van saagmeule wat gedurende die huidige oorlog opgerig is, sou 'n verdere aansporing vir beide Staat en private kwekers wees om bebossing voort te sit.

Wat inheemse bosse betref het die Vereniging daarin geslaag om openbare mening daarop te vestig deur hulle as beskermmiddels hul bewaring te bepleit, en 'n toenemende besef van die mens se plig in die bewaring van sy land se natuurlike hulpbronne en innemendhede kon verwag word.

Alhoewel vrees mag bestaan dat eienaars van private plantasies deur dringende vereistes beweeg mag word om hulle oeste te wen sonder om behoorlike maatreels te neem om hulle herbebossing te verseker, wat oeste van kort rotasie, soos gom en wattels betref, was so'n toevalligheid van betreklik min gevaar, daar die herbebossing daarvan maaklik behaal kon word, en die beste leiding gewoonlik uit plaaslike voorbeelde daaroor verkrybaar was.

Wat keëldraende soorte betref, wat eers in 'n toekomstige geslag ryp mag word, is die toestand moeiliker. Dit was te hope dat huidige omstandighede genoegsame aanmoediging vir kwekers sou lewer om hulle oeste te laat herskep. Die vernaamste soorte sou hulle gewoonlik natuurlikerwys van saad af herkweek mits geskikte behandeling toegepas is. Die Staat is altyd bereid om private kwekers met raad in hierdie en andere bosboukundige opsigte te help. Alhoewel private bosse en plantasies onder die nuwe wet as beskermde bosse en plantasies geproklameer kan word, sou die Staat liewer deur samewerking met eienaars die toepassing van die beste bosboukundige praktyk probeer aanmoedig.

Terwyl die noodsaaklikheid vir definitiewe leiding in die land se bosboubeleid nog nie onstaan het nie, kon die Vereniging nuttige diens gelewer het deur geskikte artikels oor die bewerking van hout te publiseer. Ongelukkig was hierdie prysenswaardige doel onmoontlik weëns gebrek aan personeel in die Afdeling Bosbou en elders, maar dit was te hope dat sulke artikels nog in die toekoms gelewer sou word.

Die Voorsitter het verwys na die onlangs geskikte saagmeulersvereniging, na die vorming van 'n inrigting vir navorsing in leer en looiery, en na die pogings wat deur die Suid-Afrikaanse Wattelkwekersvereniging aangewend is om 'n navorsingsinrigting vir die wattelbedryf in die lewe te roep.

Ten besluite, het die Voorsitter verwys na die uitwerking wat die oorlog op die plaaslike houtnywerheid gehad het. Die noodregulasies het 'n sekere vastheid van pryse tot stand gebring, en die Regering het versekerings ontvang dat geen oorwinsmakery by houtinvoer bestaan het nie. Pryse vir plaaslike hout is gewoonlik minder as die wat vir ingevoerde hout betaal is, maar laasgenoemde het ver bo vooroorlogse pryse gestyg, en moeilikheid het bestaan om die aanvrag tegemoettekom. Saagmeulers is aangeraai om hulle winste aan vermindering van kapitaal en aan verbetering van toestelle toe te wy.

Al diegene wat belangstelling in die toekoms van die mynbedryf plaas, is angstig om verseker te word dat timmer wat nou op die mark geplaas word goed vervaardig en gedroog is. Enige vooroordeel wat anders teen plaaslike gekweekte timmer mag onstaan sal seker na die oorlog volhou.

4. Die notule van die Tweede Jaarlikse Algemene Vergadering is as gelees aangeneem weens hulle publikasie in die vyfde uitgawe van die Tydskrif. Die notule is bekragtig en goedgekeur.

5. Met betrekking tot die notule waardeur die Uitvoerende Komitee gelas is om stappe te doen om die Vereniging beter bekend te maak, het die Voorsitter berig dat 'n omsendbrief aan Bosbewaarders geadresseer is met die doel om hul menings uit te lok oor die moontlikheid vir die stigting van plaaslike komitees. Alhoewel die voorstel sekere steun ontvang het, was hulle meesal van mening dat die plan op die oomblik onvoorspoedig sou wees.

Die Ere Sekretaris-Tesourier het berig dat met die doel om die Vereniging se ledetal te versterk, hy omsendbriewe aan meer as 400 stadsrade, klubs, biblioteke, saagmeulfirmas en houtkwekers geadresseer het. Hierdie stap het tot die inlywing van 70 nuwe lede gelei. Die moontlikheid daarvan om 'n boek wat boomsoorte beskryf en afbeeld uit te gee, soos die wat deur die tabakfirmas betreffende plantgroei en diere uitgegee is, is deur die Uitvoerende Komitee in oorweging geneem.

Die Voorsitter het vir verdere voorstelle vir die vermeerdering van die Vereniging se ledetal gevra, en algemene bespreking het gevolg. Mnr. O'Connor het aanbeveel dat indiwiduele lede in sekere gebiede as propagandiste aangestel moet word.

Mnr. Brunswick, van die Pretoriase Stadsraad, het aanbeveel dat die belangstelling van die publiek in sierlike bome, byname ons inheemse soorte sowel as timmerbome gestimuleer sou word, en het verwys na proefnemings wat in die plaaslike munisipale kwekerye met inheemse bome vir straatversiering uitgevoer is. Hy het die teleurstelling van die publiek uitgespreek oor die moeilikheid om saad van inheemse bome te verkry, en het aan die hand gegee dat artikels oor die saai en kweek van sulke bome gepubliseer moet word. Hy het aanbeveel dat wat hierdie sake betref die Vereniging met die Pretoria Tuinboukundige Genootskap en die Vereniging van Superintendente van Publieke Perke en Tuine in samewerking moet tree.

Die Voorsitter het geantwoord dat die Afdeling Bosbou reeds pogings aangewend het om sy kwekeryvoorade van inheemse soorte te vermeerder, maar dat dit nie gelyke tred met die aanvraag kon hou nie. Hy het ook oor die publiek se voorkeur vir inheemse bo uitheemse boomsoorte opgemerk.

Mnr. Read het nagedink aan die teleurstellende resultate wat by vroeër pogings om die belangstelling van andere stadsrade op te wek tot stand gebring is, en mnr. Brunswick het aan die hand gegee dat vrugbaarder reelings getref kon word deur samewerking met die Vereniging van Superintendente van Publieke Perke en Tuine (Sekretaris : mnr. McInerny, Roodepoort).

Mnr. du Preez was van mening dat eksemplare van dr. Craib se omsendbriewe aan Distrikbosbeamptes, wat daardeur plaaslike belangstelling sou kon kweek, gestuur moet word.

Suggesties is geuit dat reeks kort artikels oor indiwiduele inheemse boomsoorte gepubliseer moet word.

Mnr. Turnbull is teleurgestel met die antwoorde van Bosbewaarders aan die Voorsitter se brief, en was van mening dat die stigting van een plaaslike komitee om die weg te wys deur verdere stigtings gevolg sou word. Hy het gevoel dat Pretoria goed gelee is om die nodige leiding te gee. Besonderhede van die funksies van sulke komitees moet vasgestel word. Mnr. O'Connor was van mening dat die oorlog 'n sondebok om traagheid te regvertig geword het. Die komitees moet gelyksoortig met boerevereenigings wees.

Die Voorsitter het vermeld dat hy bereid was om die saak weer met die Bosbewaarders te bespreek.

Mnr. Read het verwys na die klein aantal lede van wetgewende liggame wat by die Vereniging aangesluit het, en het aangedring dat pogings om Senatore, Volksraad- en Provinsiale Raadslede aan te werf hernu moet word.

Dr. Craib het aan die hand gegee dat die Vereniging se populariteit verhoog kon word deur meer artikels van regstreekse voordeel vir die die Tydskrif se lesers te publiseer.

6. Die Ere Sekretaris-Tesourier het toe die Jaarlikse Verslag van die Uitvoerende Komitee gelees en die Finansiele Staat voorgelê. Op 'n mosie deur mnr. O'Connor voorgestel en deur mnr. Turnbull gesekondeer is albei aangeneem.

7. Die Voorsitter het die resultate van die stemming vir nuwe ampsdraers van die Vereniging as volg aangekondig :—
Lid van die Uitvoerende Komitee : Dr. I. J. Craib.
Ere Sekretaris-Tesourier : Mnr. P. J. A. Loseby.

8. 'n Mosie van dank aan die retirerende Ere Sekretaris-Tesourier, dr. Craib, is deur mnr. Turnbull voorgestel. Dit is deur mnr. O'Connor gesekondeer en met toejuiging aangeneem.

9. Vir oorweging van lede het mnr. Read aanbeveel dat met die oog op die toestand van sake wat na die oorlog mag ontstaan, spesiale aandag aan die gebruik van houtafval vir sulke doeleindes as die vervaardiging van sellulose en paphoutmateriaal behoort te word. Hy het ook na meer uitgebreide bebossing met gomsoorte, by name *Eucalyptus saligna* aangedring, en het die Afdeling Bosbou gekritiseer oor sy beleid van gomplantasies in plantasies van dennebome te verander. Mnr. Eckbo het mnr. Read steun geleen, en het gesê dat toepaslike gebruike vir gomhout deur die Bosprodukteinrigting uitgevind is. Hy het opgemerk dat van alle boomsoorte *Euc. saligna* waarskynlik die hoogste opbrengs sellulose per morg lewer. Bestaande gomplantasies moet behou word en nuwe grond moet vir die bebossing met dennebome opsygesit word.
Die Voorsitter het hierdie opmerkings verwelkom. Hy het gesê dat dit die beleid van die Regering was om die kweek van mynhout aan private onderneming oor te laat, en die probleem van verkoop van uitdunnings was dus 'n hindernis aan verdere uitbreidings van gomaanplanting. Baie van die oorplasing is van gomsoorte wat nie goed gegroei het nie. Wat *Euc. saligna* betref was hy eens met die vorige sprekers, en die Regering was bewus van die noodsaaklikheid daarvan om ondersoek in die moontlikhede van hierdie soort te behartig.

10. Op 'n mosie wat deur mnr. Watt voorgestel, en deur mnr. King gesekondeer is, is die Ere Redakteur, mnr. Turnbull, met eenstemigheid hartlik bedank.

11. Met aanneming van 'n eenstemige mosie van dank aan die Voorsitter, is die vergadering op 10.20 n.m. verdaag.

(Get.) P. J. A. LOSEBY,
Ere Sekretaris-Tesourier.
29 Augustus, 1941.

SUID-AFRIKAANSE

INKOMSTE EN UITGAWE REKENING

UITGAWE

Vir Publikasie van Tydskrif	£355 12 9			
Plus Bedrag Verskuldig	190 9 9			
	£546 2 6			
Min Bedrag Uitstaande in 1939/40	157 6 2	£388	16	4
Vir Herdrukke		58	12	0
Vir Skryfbehoeftes en Kantoorbenodighede		12	4	0
Vir Posseëls en -fooie		10	7	0
Vir Bankkommissie en Diskonto op Wissels		6	2	10
Vir Bankfooie		1	6	3
Vir Diverse Uitgawes		2	18	6
Saldo (Oorskot van Inkomste oor Uitgawes vir 1940/41)		97	19	9
		£578	6	8

BALANSSTAAT OP

LASTE

Subskripsies Vooruitbetaal—				
Lewenslange Lede	£76 13 0			
Ander Lede	14 8 0	£91	1	0
Tydskrifte Vooruitbetaal		1	1	0
Herdrukke Vooruitbetaal		3	2	0
Diverse Krediteure		190	9	9
Kapitaalrekening—				
Oorskot vir 1938/39	£23 5 6			
Oorskot vir 1939/40	125 18 4			
Oorskot vir 1940/41	97 19 9	247	3	7
		£532	17	4

Ek sertifiseer hiermee dat ek die boeke en rekeninge van die Suid-Rekening en Balansstaat die Vereniging se posisie juis weergee.

BOSBOUVERENIGING

VIR DIE JAAR GEËINDIG 31 MEI 1941

INKOMSTE

Per Subskripsies—				
Lewenslange Leds				£6 6 0
Ander Lede	£316 14 0			
Plus Subskripsies Voorheen Betaal	5 7 6			
	£322 1 6			
Min Agterstallige Betalings	1 8 6			
	£320 13 0			
Min Vooruitbetalings	11 15 6			
	£308 17 6			
Plus Subskripsies Uitstaande	25 2 6			334 0 0
Per Verkoop van Tydskrifte	£148 9 3			
Plus Betalings Voorheen Ontvang	2 3 6			
	£150 12 9			
Min Agterstallige Betalings	40 10 6			
	£110 2 3			
Min Vooruitbetalings	1 1 0			
	£109 1 3			
Plus Bedrag Uitstaande	4 8 6			113 9 9
Per Verkoop van Herdrukke	£85 6 3			
Min Agterstallige Betalings	39 8 3			
	£45 18 0			
Min Vooruitbetalings	3 2 0			
	£42 16 0			
Plus Bedrag Uitstaande	58 13 6			101 9 6
Per Advertensies	£23 11 6			
Min Agterstallige Betalings	14 13 6			
	£8 18 0			
Plus Bedrag Uitstaande	12 3 8			21 1 8
Per Kommissie op Tjeks				1 19 9
				£578 6 8

31 MEI 1941

BATE

Kontant in Bank	£425 7 4		
Kontant op Hande	1 11 6	£426	18 10
Diverse Skuldenare		80	16 0
Agterstallige Subskripsies		25	2 6
		£532	17 4

Afrikaanse Bosbouvereniging nagegaan het en dat bostaande Inkomste en Uitgawe

(Get.) A. N. WHITE.

27 Augustus 1941.

EDITORIAL COMMITTEE.

J. M. TURNBULL, DIP.FOR.—*Chairman.*

I. J. CRAIB, M.F. PH.D.

A. JURRIAANSE, B.SC. (AGRIC.), B.SC. (FY.)

J. D. KEET, M.A. (HON.) (*Ex officio.*)

PROFESSOR E. J. NEETHLING, B.A., M.F.

A. J. O'CONNOR, DIP.FOR.

PROFESSOR JOHN PHILLIPS, D.SC., F.R.S.E., F.L.S.

Contributions on any aspects of forestry or allied subjects will be considered by the Editorial Committee, and should be addressed to the Editor, The Journal of the South African Forestry Association, P.O. Box 727, Pretoria. Articles in excess of 1,000 words should be accompanied by uncopyrighted summaries, not exceeding five per cent. of length of originals. Twelve reprints of each article will be furnished to its author, free. Reprints beyond that number may be obtained, if ordered before the end of the month preceding that of issue, at the following rates per unit of four text pages :—

100	*copies*	*£0 16 6*
250	*,,*	*£1 5 6*
500	*,,*	*£2 0 6*
1,000	*,,*	*£3 10 6*

Incomplete units will be charged as for complete units. Printed covers ordered at same time as the text will be provided at 21/6 per 100, and 2/- for every 50 in excess thereof. Illustrations extra by arrangement.

Articles will be published in the language in which they are submitted. Summaries may be submitted in either or both official languages.

The Association does not hold itself responsible for statements or views expressed by authors.

Readers are urged to consider the Association's advertisers as occasion may arise.

REDAKSIE-KOMITEE.

J. M. TURNBULL, DIP.FOR. —*Voorsitter.*

I. J. CRAIB, M.F., PH.D.

A. JURRIAANSE, B.SC. (LB.), B.SC. (BSB.)

J. D. KEET, M.A. (ERE.) (*Ex officio.*)

PROFESSOR E. J. NEETHLING, B.A., M.F.

A. J. O'CONNOR, DIP.FOR.

PROFESSOR JOHN PHILLIPS, D.SC., F.R.S.E., F.L.S.

Artikels oor alle aspekte van bosbou sal deur die Redaksie-Komitee in oorweging geneem word, en moet aan die Redakteur, ,,Die Tydskrif van die Suid-Afrikaanse Bosbouvereniging,'' Posbus 727, Pretoria, gerig word. Artikels van meer as 1,000 woorde moet van 'n opsomming waarvan kopiereg nie voorbehou is nie, van nie meer as vyf persent van die lengte van die artikel self vergesel word. Twaalf herdrukke van elke artikel sal kosteloos aan die skrywer daarvan verskaf word. Mits hulle bestel word voor die einde van die maand voorafgaande die van uitgawe, kan herdrukke bo hierdie hoeveelheid teen die volgende pryse vir eenhede van vier teksblaaie verkry word :—

100	*kopies*	*£0 16 6*
250	*,,*	*£1 5 6*
500	*,,*	*£2 0 6*
1,000	*,,*	*£3 10 6*

Onvolledige eenhede sal teen dieselfde prys as volledige eenhede gereken word. Gedrukte omslae, bestel belyktydig met die herdrukke, sal voorsien word teen 21/6 per 100, en 2/- per elke 50 bo die eerste 100. Illustrasies ekstra.

Kontribusies sal gepubliseer word in die taal waarin hulle ingestuur word. Opsommings mag in enige of beide amptelike tale ingedien word.

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of opinies van skrywers nie.

Lesers word versoek om die Vereniging se adverteerders waar gerieflik, in aanmerking te neem.

CONTENTS—INHOUD

The Association does not hold itself responsible for statements or views expressed by authors. With the exception of authors' summaries copyright of all articles is reserved.

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of menings wat deur skrywers uitgespreek mag word nie. Met uitsondering van skrywers se opsommings, word kopiereg van alle artikels voorbehou.

PAGE
BLADSY

EDITORIAL NOTES AND COMMENTS 1

STINKWOOD.

SNAKE-BITE SERUM FOR THE FORCES.

THE LATE DR. GALPIN.

THE ESTABLISHMENT AND MAINTENANCE OF FRESHWATER FISH IN SOUTH AFRICA, *by D. Hey, D.Sc.* Part II: Stocking Rivers and Streams 4

DIURNAL FLUCTUATIONS IN JONKERSHOEK STREAMS DUE TO EVAPORATION AND TRANSPIRATION, *by C. L. Wicht, B.Sc., B.A., Dr.Ing.* 34

EUCALYPTUS SALIGNA AND SOIL RECLAMATION, *by H. A. Read, F.S.A.A.* 50

KNIKFORMULES IN DIE ALGEMEEN MET SPESIALE VERWYSING NA 'N NUWE VERGELYKING, *deur H. L. Malherbe, B.Sc.(Bsb.), L.I.K.B.* 53

THE PROPERTIES AND USES OF SOUTH AFRICAN KIAAT *(Pterocarpus angolensis)* TIMBER, *by M. H. Scott, B.Sc.* 61

THE RELATIONSHIP BETWEEN MODULUS OF RUPTURE AND WEIGHT IN SOUTH AFRICAN GROWN PINE TIMBER, *by John M. Turnbull, Dip. For.* 67

CORRESPONDENCE 78

THE VALUE OF AN IMMATURE PLANTATION.

PRESERVATION OF INDIGENOUS FORESTS.

INTRODUCTION OF POPULUS DELTOIDES TO SOUTH AFRICA.

DESTRUCTION OF NATIVE TREES BY LANDOWNERS.

SUPPLY OF SNAKE-BITE SERUM FOR THE FORCES.

REVIEWS 82

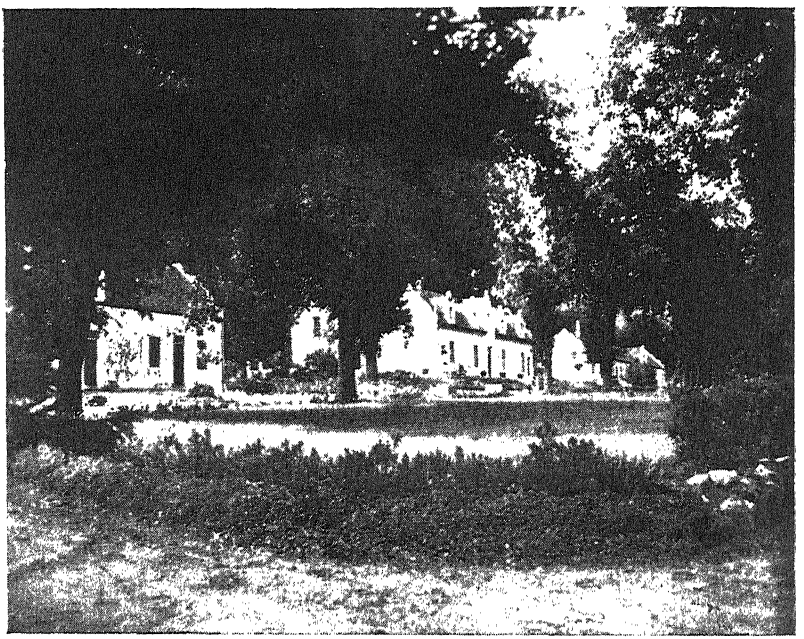
THE SUITABILITY OF SUPPORTS USED UNDERGROUND ON THE WITWATERSRAND.

A CROSS-SHAFT OVERHEAD FAN KILN.

INTERCEPTION AND STEMFLOW IN A PINE PLANTATION

ERRATA.

P. 60, fourth identity from end: Transpose left hand expression.



THE MANOR HOUSE, JONKERSHOEK, STELLENBOSCH.
Forest Influences Research Station for Winter Rainfall Areas.

THE JOURNAL OF THE
SOUTH AFRICAN FORESTRY ASSOCIATION
No. 7. OCTOBER, 1941.

DIE TYDSKRIF VAN DIE
SUID-AFRIKAANSE BOSBOUVERENIGING
No. 7. OKTOBER, 1941.

EDITORIAL NOTES AND COMMENTS

STINKWOOD.

The disposal by public auction on the 13th October of some 2,600 cubic feet of rough-sawn, kiln-seasoned stinkwood *(Ocotea bullata)*, being part of a stock accumulated during the last few years at the Forest Products Institute, Pretoria West, for Government building projects which have been abandoned since the outbreak of war, at prices for the various lots ranging according to quality from 5 to 41 shillings a cubic foot, provides ample testimony to the hold on the market that this time-honoured favourite amongst South African timbers retains in the face of competition offered by imported substitutes such as canela and imbuia, hitherto placed on the market unhampered by any official ban under the alluring title of "imported stinkwood," frequently with all too little emphasis on the "imported." These Brazilian woods, in the same state as the recently auctioned stinkwood, are obtainable by the furniture trade at comparatively very low prices, and although it cannot definitely be claimed that in their absence the former would have fetched still higher prices, it is certainly undesirable that their assumption of the name "stinkwood," however modified, should be perpetuated. A comparison of the properties and structure of stinkwood and so-called "imported stinkwood" appeared in our fifth issue under the title "An Interloper from Brazil," by M. H. Scott, from which it would appear that the Brazilian woods in appearance, working qualities and stability can sell on their own merits without being boosted up by an imitative nomenclature. Even, however, were they indistinguishable from the handsomest types of stinkwood, pride in ownership amongst South Africans of furniture made from the "genuine article" would alone justify any measure designed to protect purchasers against the consequences of irresponsible nomenclature, and it is gratifying to find published in the *Government Gazette* of the 17th October a proclamation (No. 197 of 1941) having

this purpose in view. This proclamation directs that from the date of its publication the timber of *Ocotea bullata,* E. Mey, originating in South Africa, " imported into or exported from or sold or otherwise disposed of in the Union, shall be known by the trade name or description " of stinkwood, and that the use of any other trade name or description in respect of it or of its products shall be prohibited. The proclamation similarly proscribes any name other than "imbuia" for *Phoebe porosa* (Nees) Mez. of South American origin, and " canela " for the imposing embraciveness of " all other [South American] species of Lauraceae and all [South American] species of Magnoliaceae, Rutaceae, Luguminosae, Euphorbiaceae and Styraceae."

The proclamation, which also fixes the trade name in South Africa for Parana pine *(Araucaria braziliana,* Richard), is the first instance on record in South Africa of attempts being made by the State to control trade names for timber, and is an early and beneficent outcome of the new Forestry and Veld Conservation Act (No. 13 of 1941), under authority of which it is promulgated. It should give a valuable lead to the South African Standards Institution which we learn has in hand at the present time the compilation of an extended list of trade names for South African grown timbers.

Each version of the proclamation is consistent in itself, but whereas in the English one a single name is prescribed in respect both of stinkwood and Parana pine, the Afrikaans one indulgently admits "stinkhout" and " Parana-den." A parallel anomaly affects, of course, the Afrikaans version. Surely provision should have been made in each version for the two approved names of each of these species!

Snake-Bite Serum for the Forces.

Readers' attention is drawn to a letter received from the Director of the South African Institute of Medical Research printed in this issue, in which an appeal is made for assistance in the supply of Cape Cobras and Puff Adders to snake parks or to the Institute for the purpose of venom extraction. In a subsequent communication, the Director remarks:

> We are quite unable to meet the demand for Antivenene for troops in the North because of the shortage of venom. As you are aware, the Antivenene is produced by injecting graduated doses of venom into horses. Unless the supply of snakes (or venom) is greatly increased, it will not be possible for us to increase the production of Antivenene.

As a great number of our members are actively engaged in forestry pursuits in which they are frequently encountering the sources of the venom indicated, it is hoped the Director's appeal will meet with a ready response.

The Late Dr. Galpin.

With the death at Naboomspruit on the 16th October of Dr. Ernest E. Galpin at the ripe age of 83, South Africa has lost yet another of her great botanists. In the 16,000 sheets of herbarium specimens presented by him to the Nation in 1917, representing the personal collectings of over 35 years, Dr. Galpin has left behind him a monument that becomes the more enduring as from year to year they help swell the descriptive annals of our indigenous flora. Born at Grahamstown and educated at St.

Andrews College in that City, after seeing active service in the Gaika-Galeka Rebellion of 1877, young Galpin entered the service of the Oriental Banking Corporation, to be known later as the Bank of Africa, and assumed in turn managerial posts at Grahamstown, Middelburg, Barberton and Queenstown. Throughout his commercial career, botany was for him an absorbing pastime, which he pursued with a zeal and aptitude that earned for him well-merited scientific eminence. At the official opening of the National Herbarium at Pretoria in 1923, he was singled out by General Smuts from a group of "some of the greatest botanists of the world" who were present on that occasion as "the prince of South African collectors." His collecting ardour took him into every corner of the four Provinces of the Union, and to Rhodesia, South-West Africa and British East Africa. Besides his magnificent gift of specimens to the Nation, his name is perpetuated in a large number of botanical specific epithets and in that of the genus *Galpinia*. By foresters his name will always be recalled in the specific name of one of the major timber species of the Transvaal, matumi, or *Adina Galpini*, and four or five other tree species. Botanical species discovered by Galpin run into hundreds. His publications were numerous, including *The Native Trees of the Springbok Flats*, his *Botanical Survey of the Springbok Flats*. The *Flora of the Drakensberg* and *The Fertilisation of Flowers*. In collaboration with his son, Mr. E. A. Galpin, he produced *Biological Notes on* Boscia rehmanniana *and* Olea verrucosa. After retirement from the Bank in 1917, he settled at Mosdene, Naboomspruit, where he devoted himself up to the last to botanical research and writing. Dr. Galpin had been a Fellow of the Linnaean Society for more than half a century, and received the honorary degree of Doctor of Science from the University of the Witwatersrand in 1935. He was a life member of both the South African and the British Associations for the Advancement of Science.

THE ESTABLISHMENT AND MAINTENANCE OF FRESHWATER FISH IN SOUTH AFRICA

By D. HEY

(Assistant Curator, Jonkershoek Trout Hatchery.)

II. STOCKING RIVERS AND STREAMS

The most evident characteristic of streams in general is their lack of stability. Constantly changing from month to month, from season to season, stream conditions offer a highly unstable and complicated pattern of interdependent influences, each of which has its role to play for good or ill. Man has merely accentuated the instability of streams by destroying the ground cover of the land.—J. G. Needham.

OWING to the dearth of indigenous edible and sporting fish in the rivers and streams of South Africa, the development of inland fisheries has centred around the introduction and acclimatisation of exotic species. The first step in this direction was the introduction of trout in 1890. The early work was undertaken by a few private enthusiasts, there being no qualified pisciculturists in South Africa at the time, and the history of this pioneer endeavour has been fully described by Harrison (7). Until 1927, trout were the only game fish available and were placed in any waters which appeared suitable. If they failed to establish themselves, repeated re-stockings were made without any attempt to ascertain the reasons for this failure. Consequently, hundreds of thousands of valuable fry and ova were wasted.

The study of the relation between fish and their environment is of recent origin. To-day we are able, in predicting the suitability or otherwise of a species to certain waters, to draw on a large store of facts which were not obtainable then, and rivers which are obviously unsuitable for trout can now be stocked with other species of game fish.

The whole question of correct and adequate stocking is one of balance. The problem is to select the most suitable species and prevent the planting of others.

Trout

It is unfortunate that good trout water is confined to limited areas in South Africa, as they are undoubtedly the premier sporting and edible fish. In sporting qualities, delicate flavour and appearance, these fish have no equal and should receive the first consideration when stocking is intended. They belong to the large family *Salmonidae*, embracing some 80 species (Travener, 30), including the salmons which are of the greatest economic importance on both the European and American continents. Although of recent origin, the family has a wide distribution over the northern half of the globe. The genus *Salmo* is represented in Europe, North America and Asia as far as the Equator, in Asia Minor to Northern

Persia, and in the Gulf of California to the Rio Grande. A distinguishing feature by which they can readily be recognised is the modification of the second dorsal fin. This merely consists of a fold of skin containing fat and is known as the adipose fin. Another very characteristic feature of the family as a whole is that the eggs, when ripe, are shed into the body cavity and are not carried to the exterior by means of oviducts.

Brown Trout (Salmo fario).

Brown trout are indigenous to the rivers and streams of Europe, but have also been acclimatised in other parts of the world, most notably New Zealand, America, India, Tasmania and Ceylon. They were successfully introduced into South Africa in 1890. Although dozens of sub-species have been listed, biologists and fish culturists now appear to be in general agreement that there is only one form of brown trout, subject to variations caused by the environment. They vary greatly in size according to the abundance of food and the extent of the water in which they live. In large lakes they scale up to 50 lbs., whereas in small mountain streams only 3 or 4 ozs. A trout lives from 14 to 20 years, but its value as a breeding fish extends only from the third to the tenth year.

The colouration differs with the locality, but in general it is dark brown on the back, shading to lighter brown, golden yellow or white on the belly. The flanks are flecked with numerous circular black spots, sometimes interspersed by bright red ones.

The body is elongated and compressed, being thickest in the middle and tapering both to the head and the tail. It is covered by a soft slimy skin through which, on the trunk and tail, the outlines of the scales can be seen. There are fourteen scales on the oblique line running forward from the root of the adipose fin to the lateral line. The scales are cycloid.

The mouth is terminal and large, the upper jaw being supported by two freely moving bones, the premaxilla in front and the maxilla behind, both bearing sharp curved teeth arranged in a single row. Internal and parallel to these is a row of palatine teeth. In the middle line of the roof of the mouth there is a double row of vomerine teeth. The lower jaw consists mainly of a bone called the dentary, bearing a single row of teeth.

The gill rakers are stiff, comb-like spines situated on the inner side of the gill arches. In trout there are 20 or less of these on the first gill arch. The membrane forming the lower margins of the gill covers is supported on rays or rods of dermal bone termed the branchiostegals, of which there are 10 to 12 in trout. The fins are also supported by bony rays. There are 9 to 12 of these rays in the anal fin (30).

The difference between the sexes is more marked in trout than in the majority of freshwater fish. In the male the whole head and especially the jaws and snout are longer and stronger than those of the female. During the breeding season these sexual diffierences become more pronounced. The lower jaw of the male becomes hooked at the tip and is used as a weapon of offence and defence. He assumes brighter mating colours and a white stripe appears in the median ventral fin immediately posterior to the vent. Whereas the body of the male is flattened laterally, that of the female becomes round and distended with ova.

Rainbow Trout (Salmo irideus).

Rainbow trout were imported into South Africa from Scotland in 1892 and Scotland in turn obtained them from Germany. They were introduced into Germany in 1880 from California by the Deutschen-Fischerei Verein. They were supposed to be *S. shasta* from the McCloud River, but nothing definite can be stated of their origin as the systematics of the American species is doubtful and the stocks are very mixed.

Rainbows are the most adaptable of trout and although they do well in the warmer waters they are essentially inhabitants of the fast turbulent mountain streams. To catch them under these conditions gives a never-to-be-forgotten thrill. It is the hardiest member of the Salmon family and will make a brave struggle for existence under the most adverse conditions. The migratory tendency of rainbows renders them unsuitable for planting in waters where downstream migrations will mean their destruction. They have completely disappeared from many South African rivers for no apparent reason. Where they have gone and why, nobody knows. Whether they migrate to the sea or not is a debatable point and no definite data is available. Unconfirmed reports have been received from the fishermen at Gordons Bay and Strand that rainbow trout have been caught in their trawl nets.

The general characteristics of rainbow trout are very similar to those of brown. The back is dark, shading to silvery white on the belly. Running the length of the body is a bright red stripe—hence the name, rainbow trout. The colour, however, varies with the food supply and environment. The bright silvery appearance is due to deposits of light-reflecting spicules known as iridiocytes on the scales of the fish. These iridiocytes consist of guanin which is derived from rich animal foods such as crustaceans. They are hardier than brown trout with respect to oxygen requirements, temperature and pollution. In Germany, notably in Munich, they are cultured in specially constructed ponds supplied by sewage effluent, just prior to its discharge into the river. They are omnivorous feeders and faster growers than brown trout under the same conditions and are consequently more suitable fish to rear for culinary purposes in small "stew" ponds. As they are more easily caught on artificial lures than brown trout, they present an easier problem to the fisherman of indifferent ability.

The Requirements of Trout.

The primary needs of any animal are food, shelter and fit conditions for reproduction. Regardless of where trout may be found their proper growth and reproduction are dependent upon good stream conditions. These latter, however, are very unstable owing to the multitude of interacting factors. A scientific stocking policy must consider these factors in conjunction with the requirements of the fish species concerned. In general, the following factors limit the distribution of trout: temperature, streamflow, oxygen content, acidity, turbidity and food supply.

Temperature.

The most important single factor governing the distribution of trout is the temperature of the water. For this reason two species of fish might be found in the same river, the one being confined to the cool upper

waters and the other to the warmer more sluggish lower reaches. In good brown trout water the maximum summer temperature should not exeed 21° C. (70° F.), and in rainbow water 24° C. (75° F.). In this connection, it should be noted that it is not the monthly or daily mean temperature, but the individual maximum on hot days, during a dry spell, that determines the distribution of trout. Lumbering in the headwaters of a stream, by removing the shade, exposes the water to the sun thus raising this daily maximum temperature to dangerous limits. The lethal temperature for rainbow trout is about 30° C. (86° F.) and is slightly lower for brown (Embody, 4). According to Smolian (29) and Creaser (2), the optimum temperature for brown trout is about 19° C. (66° F.) and is higher for rainbows. The importance of temperature will be realised more fully if it is remembered that fish are cold blooded and therefore take their temperature from their surroundings. Krogh (20) has shown conclusively that the rate of metabolism of a fish is uniformly raised or lowered by a rise or fall in temperature. At 14° C. (57° F.), food is digested as follows: live fish, 11-12 hours; liver, 7-8 hours; fish meat, 5-6 hours; insect larvae, 4-5 hours; and *Daphnia,* 3-4 hours. Digestion at 24° C. (75° F.) is twice as fast.

Waters can, however, also be too cold for trout, giving rise to mature but stunted fish of little sporting or food value.

Streamflow.

An even streamflow is characteristic of streams where the catchment is well covered with trees and shrub, thus retarding rapid run-off and giving a slow constant drainage throughout the year. Unfortunately, such conditions exist in very few South African streams. Unrestricted lumbering, repeated veld burning, and the cultivation of hill slopes have destroyed the ground cover, and this, coupled with heavy precipitation, causes fertile soil to be washed into the streams, destroying both terrestrial and acquatic resources. Hey (12) as far back as 1925 drew attention to this danger, stating:—

> Serious as the position is to-day, it will become infinitely worse in years to come unless something be done to remedy the existing state of affairs. In fact, it would be no exaggeration to say that many of the streams, especially those fed from vleis and swamps, will become mere dried-up watercourses in times of drought and raging torrents of liquid mud during floods, pouring tons of valuable alluvial soil into the sea.

In view of the example afforded by America, where the exploitation of natural resources has caused irreparable damage, it is amazing that South Africans can close their eyes to such dangers. The same acts which brought about conditions such as the " Oklahoma Dust Bowl " in America are being repeated in South Africa to-day and there can be no doubts on the final outcome.

Oxygen Content.

Unlike terrestrial animals, fish do not obtain their supply of oxygen directly from the atmosphere, but it is absorbed from the water passing over their gills. It is obvious, therefore, that water suitable for the maintenance of fish must carry a sufficient amount of gaseous oxygen in solution. In general, it may be stated that water containing dissolved oxygen above 50 per cent. of the saturation value is suitable trout

water, but rainbow trout will stand a greater oxygen deficiency than brown trout. The major factors determining the amounts of oxygen dissolved in water are the following: temperature, pressure, abundance of aquatic plants and organisms, the amount of oxygen-consuming materials present and the amount of natural aeration by atmospheric air (rapids, waterfalls).

Fish absorb the dissolved oxygen in the water and give off carbon dioxide by means of their gills. This gas is utilised by aquatic plants in the process of photosynthesis which consists essentially of the conversion of the carbon dioxide absorbed into starch in the presence of sunlight, and an accompanying liberation of oxygen. The amount of oxygen used by the plant during the day for respiration, which proceeds at the same time as photosynthesis, is negligible, but after dark, when photosynthesis ceases, respiration alone proceeds and the large amounts of oxygen stored during the day are consumed. The oxygen content of the water is, therefore, usually at its lowest early in the morning. In this way a delicate balance between the carbon dioxide and oxygen saturation of the water is maintained. In natural unpolluted streams the available oxygen seldom falls below the minimum required by trout. Where such conditions exist, however, the only recourse is to stock with warm-water species which are not so sensitive to oxygen deficiency.

Acidity.

The acidity of a natural water may be due either to the chemical composition of that water, or to the dissolved carbon dioxide produced by aquatic fauna and flora during respiration. The normal balance between the free atmospheric carbon dioxide and the amount dissolved in water is about pH 6.8. Water draining from peaty marshes is highly acid due to the humic and tannic acids present in solution. Bore-hole water and some spring waters are high in carbon dioxide and low in oxygen. The latter condition can be rectified by running the water in an open furrow, with small waterfalls along its course, for a few hundred yards. High carbon dioxide saturation is not usually harmful unless accompanied by a low oxygen supply.

Trout will tolerate a pH range from 5.0 to 8.0 without any apparent ill-effects, and brown trout in particular will thrive in more highly-acid water than rainbows. In the Steenbras reservoir brown trout are found in water the pH of which sometimes drops as low as 4.2. Here, however, they have failed to reproduce themselves, due, most likely, to the lethal effect of the acid water on the milt (Hey, 13).

Turbidity.

The penetration of light into water engenders the growth of green plants. Upon these, aquatic animals are either directly or indirectly dependent for food. Minerals in solution, microscopic organisms, plant and animal remains, silt, etc., impede the penetration of light into water. Waters draining from bogs or heavily forested regions, or those containing submerged plants are usually dark brown in colour, and this also impedes the penetration of light. The water in the majority of rivers and lakes in the Western Province is highly coloured owing to the acres of palmiet through which it seeps at its source. The rivers draining from the heavily forested regions round George and Knysna are also brown in colour and

poor in aquatic life. Trout require clear water, free from solids in suspension. Occasional spates do no harm provided that the water clears within a few days.

Food Supply.

The food of trout is very heterogeneous, but in general may be divided into three categories, viz., surface, midwater and bottom foods. Surface food consists largely of terrestrial forms which have been blown on to the water, and to a lesser extent of aquatic forms living on the surface, such as adult may flies *(Ephemerida)*, dragon flies *(Odonata)* and water beetles. The midwater food includes those aquatic forms which are normally found swimming freely in the water, such as small fish, aquatic insects, crustaceans, etc. The bottom food is comprised of those organisms usually found crawling on the banks and bottom of the river, e.g., insect larvae, shrimps, molluscs, crabs, worms, etc.

Life History.

The life histories of rainbow and brown trout are practically identical and a general description follows. Before the mating season the majority of Salmonoid fishes ascend the rivers to spawn. Pacific salmon may travel many thousands of miles to reach the spawning beds, and after the spawning act they die. It has been estimated that the Salmon ascending the Yukon river travel some 3,000 miles in addition to the long migration while still at sea. In trout the migratory instinct is also definitely developed, but as these spend all their life in fresh water there is no need to journey so far. At the beginning of the winter months they travel some distance upstream in search of suitable gravel beds. Lake trout ascend the feeder streams. In New Zealand, according to Hobbs (17), this migratory instinct appears to be suppressed as the distribution of redds agrees very closely with the summer distribution of the fish.

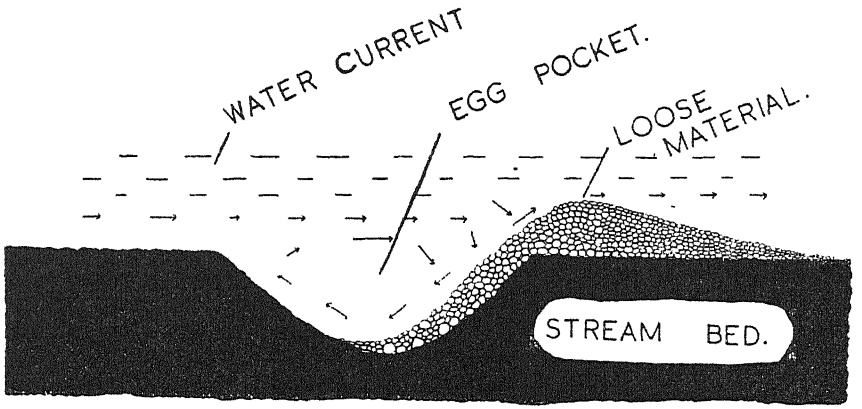


FIG. 1.—Section of a redd (after Hobbs).

When trout ascend the streams to spawn the female chooses a suitable bed of gravel, in water 1 to 3 feet deep. She then commences making the nest or " redd " (see Fig. 1). She turns on her side and vigorously flexes her body against the bottom. Her tail, during these movements,

sets up strong hydraulic forces which lift the gravel and sand off the bottom. This activity is continued until a small pit or depression is formed, the loose material collecting below the redd. The male takes no part in the nest building, but waits inactively near the bottom of the redd. During the process he may try to stimulate the female by swimming to her side and quivering slightly. Frequently he will swim back and forth over the female, caressing her with his body and dorsal fins. He may also nudge her gently in the belly with his snout. This act is the origin of the belief that the male squeezes the eggs from the female.

After a depression has been formed, the female lies in the deepest portion and the male moves up next to her. Both fish open their mouths, and this causes the current to force them closer together against the bottom of the nest, with their vents opposed. Eggs and milt are exuded with a quivering motion by both fish at exactly the same instant (Needham, 23). The eggs drop into the bottom of the nest and the milt settles in a more or less compact manner about the eggs. The millions of spermatozoa composing the milt are inactive until they enter the water. They are then violently active for about a minute.

The eggs are circular elastic bodies, about .22 inches in diameter, of a clear white, yellow or coral colour. The outer coat is porous, elastic and tough. When first exuded they are soft, but rapidly absorb water which fills up the interspace, the perivitelline space, between the yolk and the egg membrane. Consequently, the eggs swell up to about a third larger than when laid and at the same time become turgid. When dropped they bounce like rubber balls and will support a weight of 5.14 pounds without bursting (Peart, 25).

After the first spawning act, the female moves slightly upstream, and, by repeating the nest-building activity already described, covers the eggs with gravel. In the new depression formed, spawning again takes place. This activity is continued until the female is spent, and in this way the eggs are buried over an extensive area. No other fish are permitted to approach the redd, and in addition to driving them off, the male constantly makes excursions over the spawning grounds with the deliberate intention of biting and chasing any intruders.

According to Hobbs (17), who has studied the spawning activities of rainbow trout in New Zealand, the eggs are densely massed in a few egg pockets. The same female, however, may deposit her eggs in from one to at least three different redds. Needham (23), who has made careful observations on the spawning of steelheads in America, describes the nest as being 12 feet by 5 feet and containing six or seven egg pockets. Greeley (6) asserts that only one act of spawning takes place, but that the female may take as long as two days over the construction of the redd.

It has been claimed that gravel is not necessary for the spawning of rainbow trout. Worthington (32) (quoted from Hughes-Barry) states that in the headwaters of creeks in Utah there are pools several yards in diameter, one to two feet deep and full of weed. During March and April these are literally a moving mass of spawning trout, not on redds or gravel, as brown trout spawn, but right among the weeds. It was said by knowledgeable men on the spot that rainbow trout must have weed to spawn in, and this accounts for the old Indian belief that they wrap themselves up in weeds so as to force the spawn out. In these

accumulations piles of fish used to be dragged out, entangled in the weeds, by brown and red bears and minks.

Her duties completed, the female trout drops down into deeper water, but the male, as a rule, remains near the edge of the spawning ground, descending to the deeper water later in the year. Once the eggs are deposited and covered no further parental care is given to them.

Some diversity of opinion exists on the efficacy of natural spawning. All older writers are unanimous in attributing to it a very low fertility —some as low as 10 per cent. Hobbs (17), however, considers it to be above 95 per cent. Frost (5), without giving any data, states, " the present writer is inclined to believe, on the basis of field observations and the present experiments, that the percentage of eggs which are fertilised, hatch and emerge from the gravel is rather high." As yet, no data on this subject from South African waters is available.

At a mean water temperature of 12° C. or 57° F., brown trout eggs hatch within 4 to 5 weeks and rainbows in a slightly shorter time. Infertile eggs usually die within the first few days. Dead eggs are clearly visible since they turn white as a result of exosmosis. Such eggs are generally attacked by fungus *(Saprolegnia)* and should there be a large number of these eggs present, the danger exists of the infection spreading to the live eggs as well. This constitutes one of the causes of loss in the redds. After about three weeks in the case of brown and two in the case of rainbow trout, the eyes of the embryo become visible in the developing egg, and a few days later the body of the small fish can be seen lying on the yolk (see Fig. 2). At this stage the ova require an adequate supply of oxygen, and should there be a heavy deposit of silt as a result of a flood, a high mortality might result.

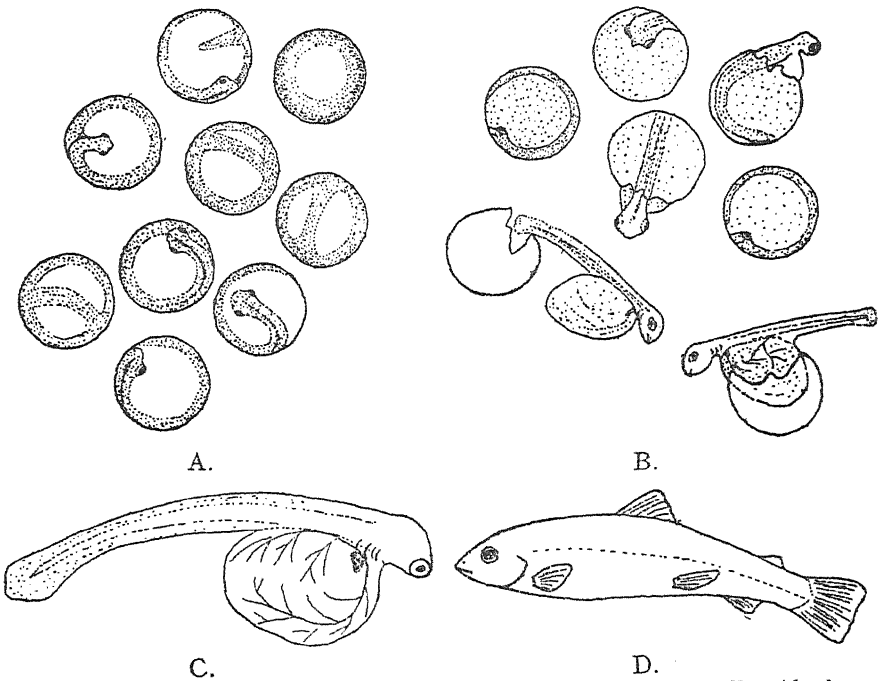


FIG. 2.—Development of the Trout. A. Eyed ova. B. Alevins hatching. C. An alevin enlarged. D. Trout fry.

Another cause of loss in the redd is the repeated use, by different fish, of the same beds in cases where there are insufficient spawning grounds. When this occurs a large number of eggs and alevins in different stages of development are destroyed.

At all stages the rate of development is directly proportional to the temperature. In the British Isles, where low water temperatures prevail (40° C. or 39° F.), hatching takes place only after three months. At Jonkershoek, rainbow eggs, which normally hatch in 34 days (12° C. or 54° F.), hatched within 21 days when the water temperature rose to 16° C. or 61° F. (Hey, 14). The newly hatched fish are provided with a large yolk sac on which they feed for about three weeks (see Plate I). During this period they are quiescent, lying hidden in the gravel away from the light. When exposed to light they " pack " tightly together in a corner, as shown in Plate II. Alevins (for so are the young trout designated) of about 3 weeks acquire a more fish-like appearance, the yolk sac having disappeared, and the fins are prominent. They now leave the redd and scatter, taking up positions which are advantageous for feeding purposes. They prefer fairly rapid, shallow water to the quieter, more sluggish stretches and are healthier when they have to hold their own against the current. They now begin feeding on small *Crustacea* such as *Cyclops* and *Daphnia*, aquatic insect larvae, etc., and are known as fry. If the feeding is good, they will mature in two years. Their enemies, however, are legion. The unprotected eggs and alevins are the prey of ducks, coot, eels, crabs, and water beetles. From the fry stage herons, kingfishers, cormorants and others take a fair toll. It has been estimated that an adult cormorant will consume twice his own weight of fish daily.

Smallmouth Black Bass

The American smallmouth black basses are also river species and may prove useful in stocking rivers which are unsuitable for trout. This group of fishes is particularly characteristic of the fresh waters of the United States east of the Rocky Mountains. These so-called black bass are not true bass, but belong to the sunfish family, *Centraarchidae*. They are all non-migratory, carnivorous, voracious and exhibit game qualities. In addition, they are excellent table fish.

There are two species of smallmouth bass. North of a line running through southern Ohio and central Missouri, and farther south only in cool mountain streams with a copious water supply, is found the northern smallmouth—*Micropterus dolomieu*—THE smallmouth or bronze-back. It usually inhabits cool, clear, swift-flowing streams, but may also be found in lakes provided that the water is cool and clear enough. This species was introduced into South Africa in 1937 under the auspices of the Cape Piscatorial Society on the initiative of the Secretary, Mr. A. C. Harrison (9). They bred for the first time at the Jonkershoek Hatchery in September/October, 1938, and since then the annual spawnings have been very satisfactory.

As shown in Fig. 3, the northern smallmouth has a number of characteristic features which distinguish it from both largemouth and spotted bass. The maxillary (the bony plate at the angle of the mouth) extends to a vertical line through the eye. The scales are smaller than those of the largemouth, 17 rows being situated on the cheek and 11 rows between the lateral line and arch of the back immediately in front of the dorsal fin.

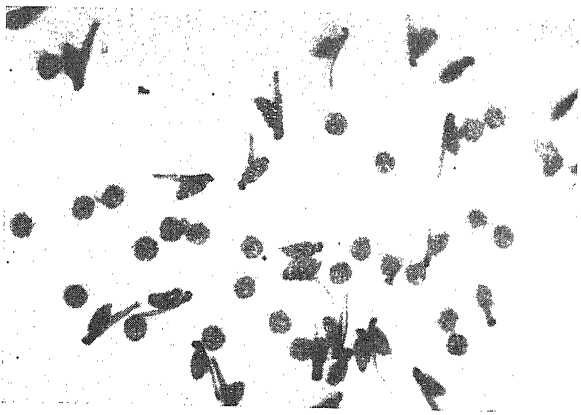


PLATE I.—Trout alevins hatching.

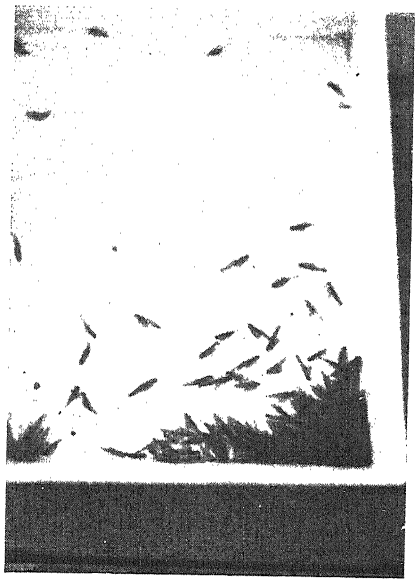


PLATE II.—Characteristic packing of trout alevins about a week old.

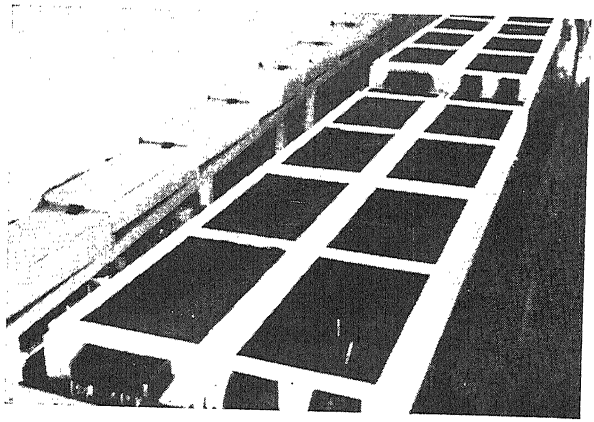


PLATE III.—Hatching troughs, Jonkershoek.

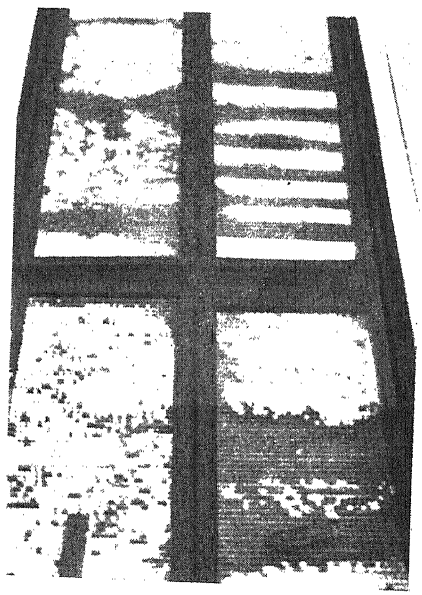


PLATE IV.—Trout ova on hatching trays.

The ovaries examined before spawning are elongated, cylindrical sacs with rounded ends. The two ovarian sacs unite and a tapering duct leads from them to the external opening situated between the anal and urinary openings. The eggs are firmly attached to ridges running crosswise to the ovary. This is in strict contrast to the condition in trout, where no oviducts are present, and for this reason bass cannot be " stripped."

South of the southern portion of Ohio and central Missouri is found the southern smallmouth or spotted bass *(Micropterus punctulatus* syn. *pseudaplites)*. It is the dominant species of the upper Ohio River. In form it is long and slender, becoming more robust with age. The dorsal fin is deeply emarginate and the body is characteristically marked by a mid-lateral series of dark, diamond-shaped blotches, which may become

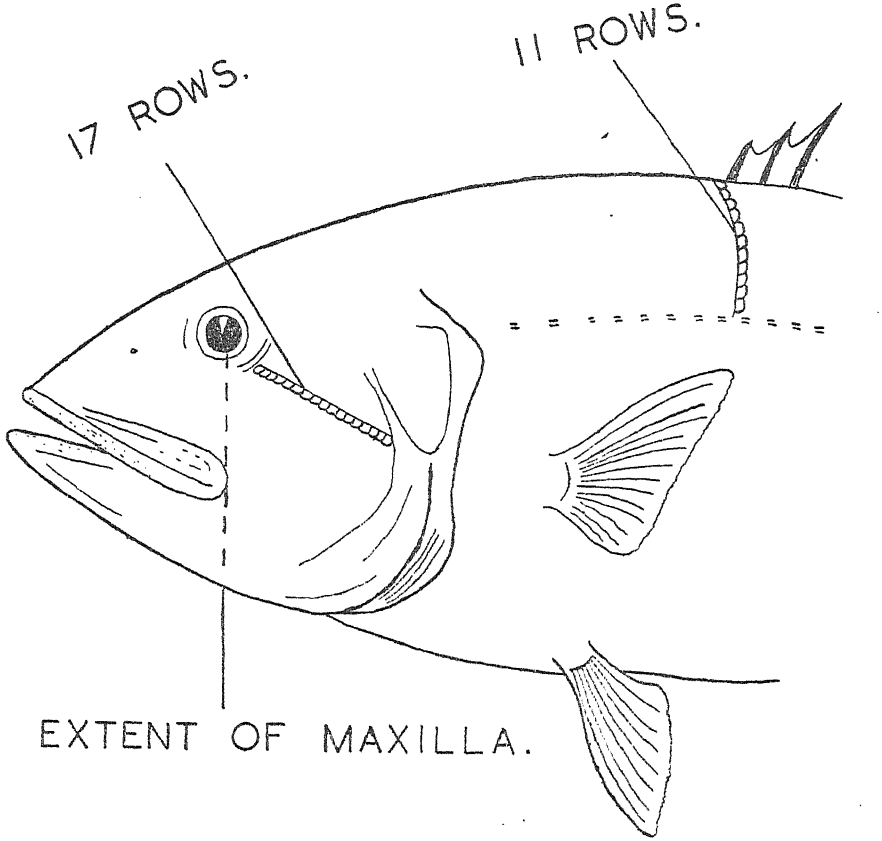


FIG. 3.—Diagram of the smallmouth bass (M. Dolomieu).

confluent posteriorly to form a definite stripe. In older specimens all the blotches tend to become confluent, forming a stripe very similar to that seen in the largemouth. The dorsal or dorso-lateral region is irregularly blotched or mottled in sharp contrast to the lighter colour below the lateral band and the whole body is crowded with distinct black dots. Radiating backwards from the eye, there are three brownish

streaks, the uppermost being darkened posteriorly, to form a pronounced black opercular spot. The lower jaw is elongated, the pectoral fin possesses 15 and the anal fin 13 rays. In addition, these southern smallmouth bass possess 14 rows of scales on the cheek, a condition intermediary between the eleven rows present in largemouth and seventeen in northern smallmouth bass. They are smaller fish than the northern smallmouth, the largest specimen to date being one of four pounds taken in the Norris Lake, Tennessee (Hubbs and Bailey, 18).

With regard to its sporting value, Viosca (31) states: "Between it and the largemouth, whose geographical range it occupies in part and which it is supposed to resemble superficially, the difference is as day and night. Less headstrong but more pluck, less inertia but more agility, less bulk but more streamline, less bulldog but more whippet, it is the bass autonym of the largemouth."

These fish were introduced into South Africa in the same way as the northern smallmouth in 1939 (Harrison, 10), and although they are essentially stream fish, they spawned successfully in the ponds at Jonkershoek in October, 1940. A number of trial stockings have been made in the more acid, peat-stained rivers of the Western Province, but as yet no data is available. Next season it is hoped to make trial distributions in the warmer cloudy waters of some of the Eastern Province rivers. A limited number of fry will also be available for private distribution.

Requirements of Northern and Southern Smallmouth Bass.

Bass are found in cool, clear water and the temperature requirements of the northern smallmouth are very similar to those of trout. For this reason a great deal of overlapping is likely to take place in South Africa where trout are established in most streams; and those which are not trout waters are likely to prove too warm even for northern smallmouths. Neither species of bass tolerates water as warm as that inhabitated by largemouth, and it is useless to try them in water heating much above 27° C. (80° F.), although they may tolerate occasional summer temperatures up to 32° C. (90° F.). In this connection, it should be remembered that for each species of fish, there is not only a maximum and a minimum temperature, within the limits of which life is possible, but also an optimum, a temperature in the presence of which a fish is at its best. It therefore stands to reason that temperatures above or below this optimum will influence the behaviour to a marked degree. Since bass tolerate such a wide range of temperature it cannot be expected that they will always be "true to type"; those living at the lower temperature limit will differ markedly from those at the upper.

As regards acidity, oxygen content and turbidity, bass will adapt themselves to a wider range of conditions than trout. There are also a number of other reasons why smallmouth bass may thrive in waters which have been proved to be indifferent trout waters. They are more predaceous than trout and consequently not only are they able to hold their own against the larger indigenous species, but the fry of the latter species serves as excellent forage for them. Bush (1) attributes the failure of rainbow trout in certain Natal rivers to the presence of the "scaley" *(Barbus elephantis)*, which feed on the ova and alevins. The breeding habits of bass, however, militate against losses in the nest

due to the raids of coarse fish. When bass fry rise from the nest they shoal, and the male parent patrols the entire length of the school, driving away all intruders. This ensures a high survival of fry. Bass spawn during September and October, whereas trout spawn from June to August. The rivers of the Western Province are usually in high flood during the latter period and this may cause considerable losses in the trout redds.

As stated above, the northern smallmouth thrives in cool clear streams and also in lakes, provided that conditions are favourable. Here it is essential that the water be clear and free from dense vegetation. Warm water smallmouths are not good breeders and there is also a greater spawn loss in warm, cloudy water. Areas of clean gravel for breeding as well as sandy bars and rocky ledges for feeding and resting are necessary.

The spotted bass is a native of streams with meandering courses, deep holes and undercut banks, alternating with bars of sand and gravel. Hubbs (10) states:—

> The spotted bass tolerates silty waters with a current. It resists high flood crests better than either of the other species. It therefore succeeds where the water is too dirty and the bottom too silty and devoid of stones for the smallmouth, and when the water has too much current and too much variation in flow for the largemouth.

It is not a lake species and when reared in ponds it must have a copious water supply. Although the adult form is able to adapt itself to a wide range of environmental conditions, the immature fry are delicate and suffer under adverse conditions. Whether they will prove successful under South African conditions remains to be seen.

Life History of the Smallmouth Bass.

Smallmouth bass spend the summer in fast water owing to the better feeding, higher oxygen content and lower temperatures obtaining there. In autumn, as the water cools, they drop back into the slack water and in these large pools breeding takes place. In America, Jones (19) has distinguished five or six general periods in the yearly life cycle: the breeding season during which the adults do not feed, followed by a feeding period when the bass make up for the loss of food during spawning; the summer rest period covering the months of heated water; the autumn feeding season; and, finally, the winter hibernation. As yet, it is too early to predict how bass will react to our conditions, but it is unlikely that our waters will be cold enough to induce winter hibernation.

The spawning period usually extends from late August to October, depending upon the latitude and advancement of the season. As soon as the water temperature rises to 13° C. (55° F.), the males begin seeking suitable spawning beds in the shallow areas, but actual spawning does not take place until the water temperature exceeds 18° C. (65° F.). Often numerous places are tested before a suitable one is located. The male not only chooses a gravel bottom of a certain coarseness, but places the nest in a sheltered spot either near the bank or behind a boulder or log, thus ensuring protection from intrusion on at least one side.

The following description of the spawning process has been modified from Reighard (27). Assuming an almost vertical position the male commences fanning the silt with his broad tail fin, sweeping the sand and gravel free of all sediment over an area of from 15 to 30 inches in

diameter. He then pushes his nose well down among the pieces of gravel to loosen them, after which he vigorously fans the loose material out towards the sides of the nest. This activity continues until a depression has been formed containing loose, clean gravel. The removal of the material from the centre of the nest and its accumulation at the border, leaves it saucer-shaped.

The male guards the nest until he finds a mate. Should no female approach the nest within a few days, he will go in search of one and may return after a considerable time driving her before him. This he does by keeping on the deep-water side and biting her body and gill covers from time to time until he edges her on to the nest. Once in the nest the two fish swim slowly around, the male biting at the mouth, gill covers and sides of the female. Occasionally they will lie quietly close together on the gravel, the female partly on her side, the male more erect. This preliminary activity may last for an hour or more. The eggs are laid in small batches and fertilised by the male. After each act of spawning the male examines the nest and eggs very carefully, and for a time they again swim round and round the nest, the male the while performing courtship acts. This activity becomes weaker and weaker towards the latter end of the spawning operation, until finally the male chases the female from the nest. Spawning may take an hour or more. The eggs are small (10 to the linear inch), round, and of a pale yellow colour; when laid they are very sticky and adhere to the lumps of gravel.

At the commencement of spawning the sexes are readily distinguishable. The female is light of colour and thick-bodied. On pressing the forefinger against the belly several inches in front of the vent, the position of the ovaries is indicated by two rounded thickened ridges, one on either side of the finger. Should these fail to appear, the fish is a male. The male is of a much darker colour than the female, and has bright red eyes. During the process of spawning, however, the female becomes darker as more eggs are deposited, until finally she attains the same dark colour as the male.

After spawning, the male assumes guard and commences a gentle fanning motion with his pectoral and tail fins, brushing away the silt from the nest and keeping the eggs clean. This activity also ensures a constant stream of fresh water over the eggs and continues until they hatch. Here again, as in the case of trout, the time taken for the eggs to hatch depends upon the temperature. At a water temperature of 18° C. (65° F.) hatching occurs within about seven days. A sudden drop in temperature below 18° C. will result in a heavy mortality of eggs. This often happens in the Western Province during early spring, and consequently the early spawnings are not very successful. The newly-hatched young fall between the pieces of gravel and are partially protected in this way. Here they remain until the yolk sac is practically absorbed. At this stage they are transparent and of a pale yellow colour. Twenty-four hours after hatching, the movements of the tail are sufficiently vigorous to cause the fish to move forward for short distances. As development proceeds they become darker, and by the time that they rise from the nest they are brownish black in colour. The quiescent yolk sac period lasts for about ten days at a water temperature of 18° C. The fry rise from the nest before the yolk sac or oil gland is completely absorbed, and the development of an air bladder further adds to their

buoyancy. For some days the shoal of young bass continue to hover about the nest, after which, accompanied by the male, it seeks shallow water. The young fish feed on *Infusoria* and small *Crustacea,* gradually increasing the size of the diet as they grow larger. Both the eggs and the young fish have numerous enemies such as small fish, larger bass, water beetles and birds, which are ever-ready to attack them during even a brief absence of the male. Against these enemies, however, the male affords a large measure of protection.

On attaining the length of about an inch the swarm disperses and each fish cares for itself. They become very wary, hiding in the dense vegetation or among the stones. Known by the vernacular name of "banner-tails," the fry are distinguished by a pale yellow spot at the base of the tail, which is fringed with black.

Spotted Bass

Spotted bass appear to resemble largemouth fairly closely in life history and breeding habits. The stock obtained from America bred in a pond at the Jonkershoek Hatchery when only 6 to 8 inches long. Nest-building commenced a week before the smallmouth, and spawning took place at a water temperature of about 18° C. (65° F.). A variety of spawning sites were chosen, some fish making nests on the hard bottom and others among the firous roots of the marginal aquatics. The depth of water varied from a few inches to two feet, but in all cases the nest was protected on at least one side. The males were most assiduous in assuring that the nests were swept free of all loose particles and silt. The eggs are intermediate in size between smallmouth and largemouth, there being 14 to the linear inch. The subsequent life history appears to correspond very closely with that of the smallmouth already described. The shoals disperse when the fry are very small and the latter are then known as "painted tails" owing to the bright orange spot at the base of the tail. Another striking feature of the fry is a lengthwise blackish streak, which closely simulates that of largemouth fry, but this disappears with age.

Stocking

Great care should be exercised in stocking virgin waters as a good deal of irreparable damage can be done by the introduction of inferior species. Once a species has become established in a natural water, it is practically impossible to eradicate it, and the water may be rendered unsuitable for superior species. In order to stock water intelligently, it is essential to be acquainted with the requirements of the species to be introduced. This includes a knowledge of the type of food required at different stages in its life cycle as well as the amount of food organisms that the water to be stocked is capable of producing.

Wherever possible, trout should be used for stocking, by planting either ova or fingerlings. These may be obtained from the Government hatcheries or by stripping adult fish as will be described below.

Stocking with Trout Ova.

Eyed ova can be obtained from the Government Trout Hatchery, Stellenbosch, or the Pirie Hatchery, King William's Town, at £2 per thousand. They are sent by post in wooden boxes, packed in muslin

bags and damp moss. The ova must be placed in the hatching apparatus as soon after arrival as possible and consequently all preparations should be made beforehand. There are three types of hatching apparatus:—

1. The " Chaplin " hatching tin.
2. The floating hatching box.
3. The hatching trough.

The " Chaplin " Hatching Tin.

This is cheaply and easily made from an ordinary paraffin tin. It is cut as indicated by the dotted lines in Fig. 4.

The tin is then perforated from the inside, the perforations being ½ inch in diameter. Upon arrival the ova are placed in the shade and carefully cooled to the temperature of the river, care being taken not to chill them. This can be avoided by opening the box and sprinkling a little water over the moss. Sprinkling is continued at intervals of a few minutes until the moss is at the same temperature as the water in the river. The tin is then placed in shallow water and a layer of about two inches of gravel (stones 1 inch in diameter), which has previously been collected and washed, is placed in it. After this the eggs are sprinkled over the gravel as one would sow seeds. It should be ensured that the hands are wet when handling the eggs and that the tin is placed out of the current. Another layer of gravel is placed carefully over the eggs and a further quantity of eggs are sown. In this way the box is filled, but at least two inches of gravel should be placed over the last layer of eggs. The tin is finally closed and wired to its original shape. Two to three thousand eggs may be hatched in a tin, but it is more effective to use one tin for each 1,000 eggs, placing them at intervals in the stream, for this ensures a more even distribution of the fry.

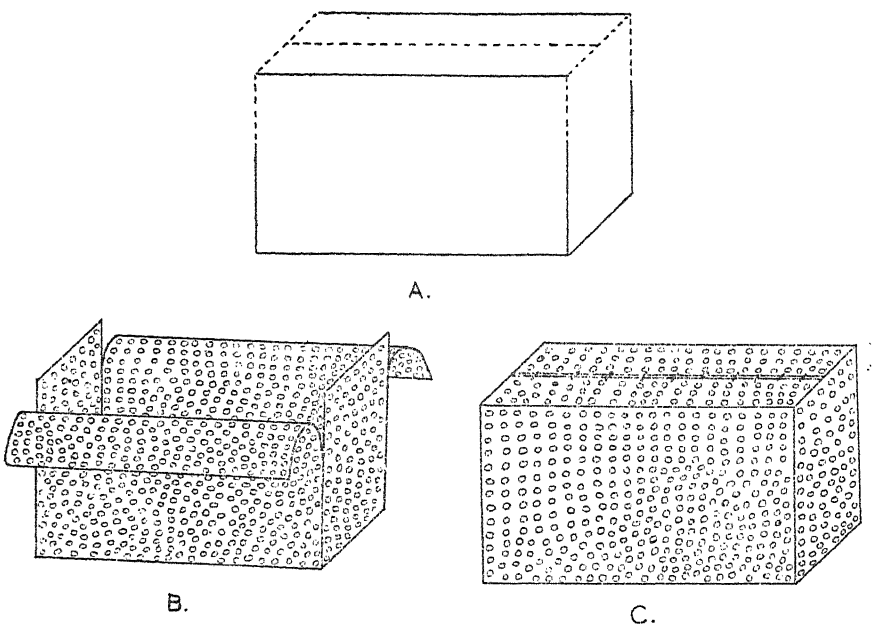


FIG. 4.—The "Chaplin" hatching tin.

The tin should be placed in a suitable rapid, broadside to the current so that water percolates through the holes, or in a pool under a small waterfall. It should rest on a clean gravel or stony bed, never on mud or silt. Once in position it should not be moved for at least a month, or the delicate young fish may be injured. It is advisable to conceal the tin in some way, as ordinarily it is very conspicuous. In the Somerset East district baboons have been known to remove hatching tins from a stream.

The eggs are despatched from the hatchery so that they will hatch within a week under normal temperature conditions. After hatching, the alevins remain in the gravel for about three weeks until the yolk sac is absorbed, and then find their way out through the holes in the tin. Within about six weeks the tin can be removed for examination and the dead ova and alevins counted. In this way some idea can be obtained of the percentage of fry hatched.

The "Chaplin" hatching apparatus has its advantages and disadvantages: it is economical and requires very little attention; it is portable and may consequently be used in mountain streams; and, finally, it has been proved fairly efficient. On the other hand, the dead eggs cannot be removed and consequently there is a danger of healthy eggs being destroyed by fungus *(Saprolegnia)*. Predators, moreover, tend to collect just below the tin and feed on the fry as they emerge.

Should the use of the hatching tin prove impracticable, ova can be planted in gravel beds in any small tributary of the main stream,

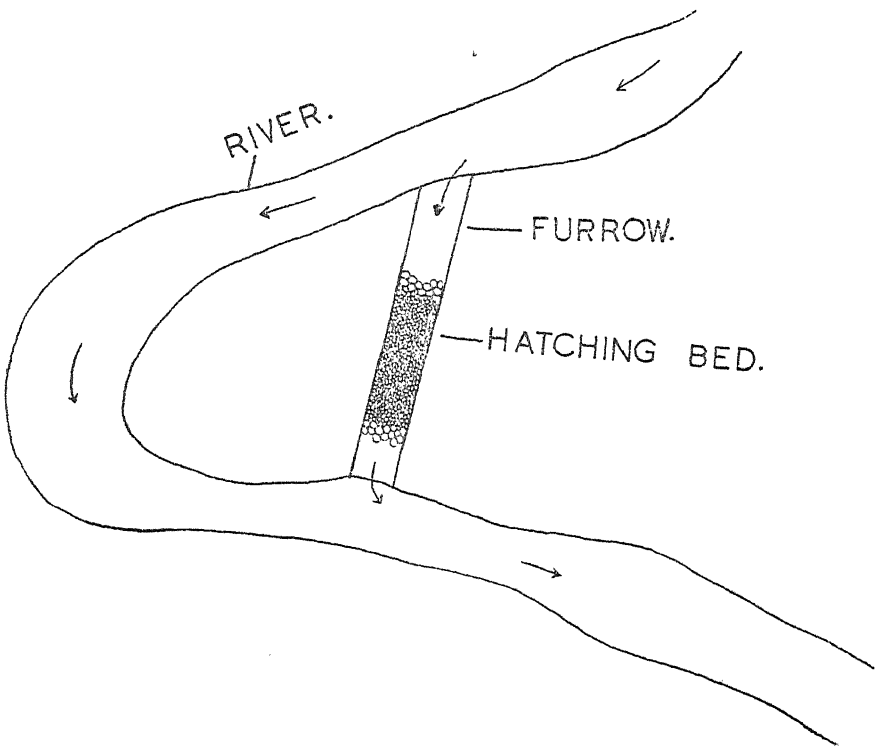


FIG. 5.—Diagram of a hatching bed.

provided that the streamflow is constant. It is advisable to choose a stream flowing into the river or dam which it is intended to stock,, as this obviates handling of the fry. The procedure of planting is as follows: the bed of the stream is covered with clean gravel ½ to 1 inch in diameter, to a depth of 4 inches below the surface. The eggs are then sown in the gravel, commencing at the upper end and distributing them as evenly as possible. The eggs will fall in the crevices between the stones and an additional layer of gravel may be placed over them. The banks of the stream must be levelled so that the hatching bed can be covered with wire netting and sacking to protect it from predators and direct sunlight.

Where no tributary streams are available, a channel can be cut at some suitable bend in the river as shown in Fig. 5. In this channel a gravel hatching bed is constructed as described above.

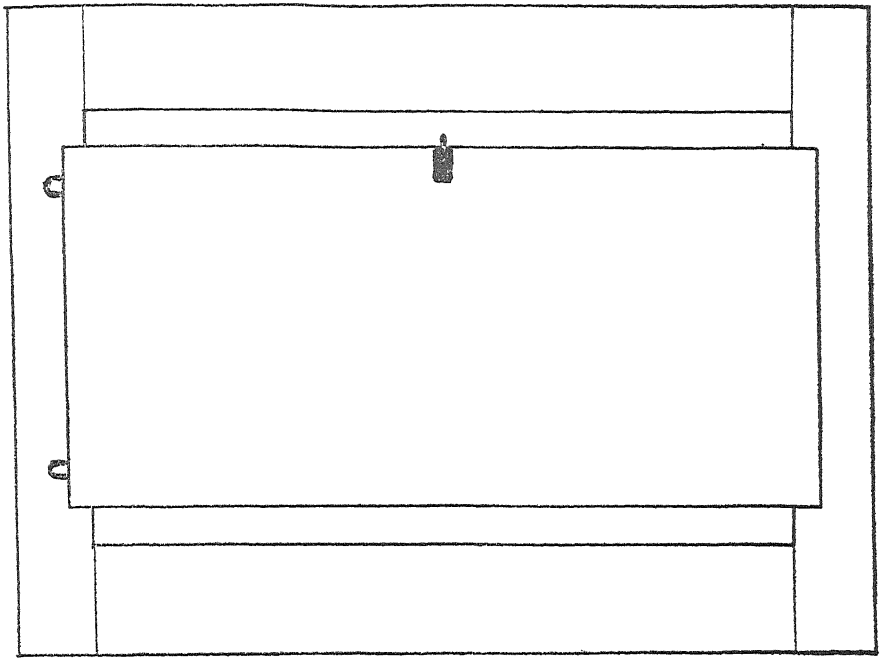
Where suitable gravel beds are to be found in the river, ova may be planted in them in rows, much as wheat is drilled into the soil. The eyed ova are best laid down by making furrows, three yards apart, across the gravel shallows with a hoe or rake. " Planting " is effected by pouring the eggs down a long funnel which has its mouth above the surface of the water. The eggs are then covered by pushing in the sides of the furrows.

The Floating Hatching Box.

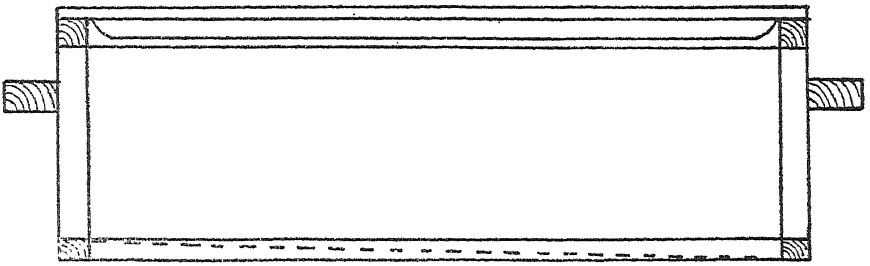
This method of hatching trout ova is very useful for angling societies and yields good results. The outfit comprises a hatching box and floats. The box consists of a wooden framework with wooden lid, covered on the sides, end and bottom with perforated zinc. The box may be of any size, but 3ft. by 1·5ft. by 1ft. is the most useful. The perforated zinc should have a mesh of 1-32 of an inch, and should be allowed to stand for twenty-four hours in strong washing-soda, after which it is thoroughly cleaned and dried. It is then bedded on strips of stout flannel and firmly nailed to the frame. The lid is made of ceiling boards, stiffened with cleats and should be fitted with a hasp, staple and padlock. At the upstream end of the box two strong wire staples should be rivetted through the top rail for the attachment of the mooring ropes.

The floats, which are arranged at the ends and sides of the box, are constructed of 5½in. by 1½in. timber as shown in Fig. 6. They should be fixed at the levels indicated, as it is essential that the box should float with a slight cant upstream to prevent the ova from collecting at the lower end. The whole apparatus must be given three coats of asphaltum or bitumen varnish.

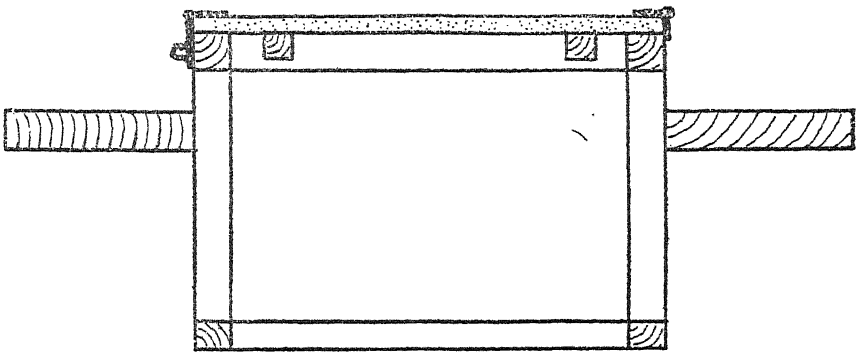
The box may be placed in any depth of water above 18 inches, below a rapid or cascade, where the stream has a clean rock or shingle bed. A gentle current through the box is essential, but this should not be strong enough to shift the eggs. It should be set with its long axis parallel to the current and in such a position that it can easily be drawn alongside the bank for daily attention. This box can also be used in reservoirs provided that it is moored in a position where the waves will cause a current through it.



PLAN.



SECTION.



The hatching box should be submerged to within about half an inch of the upper surface of the floats. The side floats are arranged with a space between them and the box for the removal of debris. They are tenoned into the end floats which, in turn, are attached to the box by large screws, easily removable for purposes of adjustment.

The hatching box should be placed in position a few days before the eggs arrive as the latter must be placed in water as soon as possible. The eggs must be handled carefully as already described and should be evenly distributed over the bottom of the box by means of a feather. It is essential that the contents of the hatching box be examined daily and all dead eggs removed (these are white in colour). This is most conveniently done with a pair of flat-nosed forceps. All debris collecting against the box should be removed daily as it will impede the flow of water.

When the alevins hatch they remain tightly packed together in the corners of the box. Dead alevins must be removed daily. They may be liberated as soon as they begin to swim freely, and this should be done a few days before the yolk sac disappears entirely, so that they may have a small stock of reserve food. Removal of alevins from the box can be effected by means of a small net. This consists of a frame of No. 6 gauge fencing wire, covered with mosquito netting so that the " bag " of the net is about one inch deep. They may be transported in enamel jugs or small milk cans, but it is not advisable to undertake journeys of over an hour. When planting the fry it is essential that the temperature of the water be brought as near that of the stream as possible. This can be done by baling out the water in the bucket, a cupful at a time, and replacing with water from the stream, until the temperatures are equal. A two-gallon watering can also makes an excellent distributing vessel, the young being liberated, a few at a time, through the spout. According to most authorities, the fry should be planted in small numbers and distributed over a wide area. They assert that if thousands or even hundreds are " dumped " in one spot, there will not be sufficient food for them all, and that they will fall a ready prey to enemies. In America, Hewitt (11) has experimented with both methods, but found no difference in the results. He " dumped " several thousand fry in one spot and in two days they were scattered over a mile of river. It is, however, very necessary that fry be placed in localities suitable for their growth, where proper food and cover are to be found.

The Hatching Trough.

The method " par excellence " of hatching trout ova and rearing them to the fry stage is by means of the hatching trough. This method can only be employed where a suitable water supply is available. By this method the eggs are protected from predators, floods with their attendant evils (silt, temperature variations) and, to a certain extent, disease. Although rather elaborate for the average individual it is highly recommended for use by angling associations and similar institutions, if large numbers of eggs are to be handled.

A hatching shed, provided with a supply of running water, is needed. It is essential that the water be cool and silt-free and the supply unfailing. Water warmer than 15° C. (59° F.) cannot be used for hatching purposes. If the water is charged with silt it must be filtered before use. An

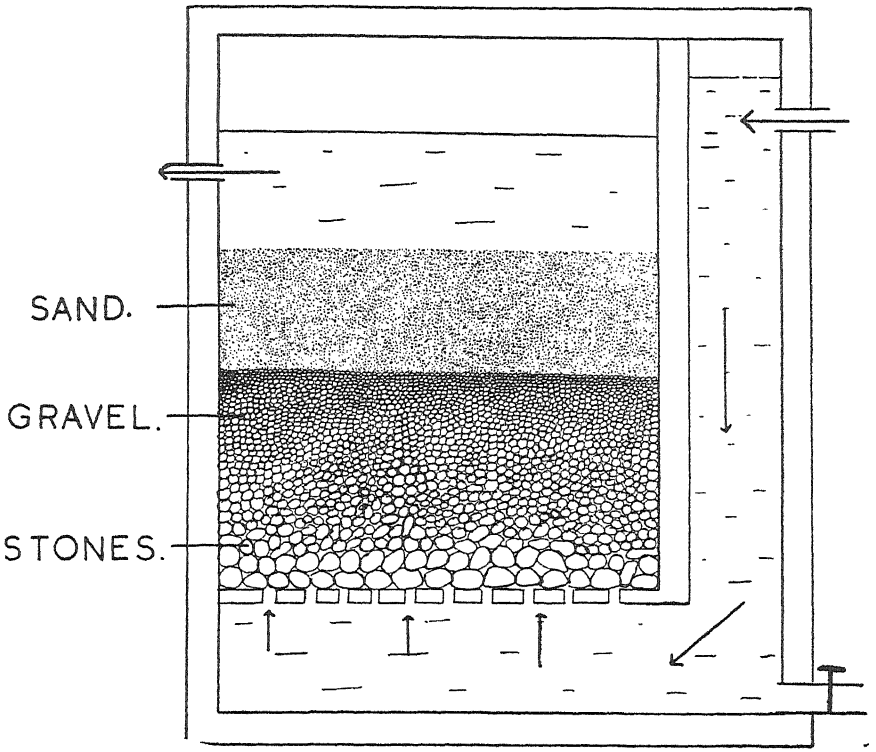


FIG. 7.—Diagram of upward filtration tank.

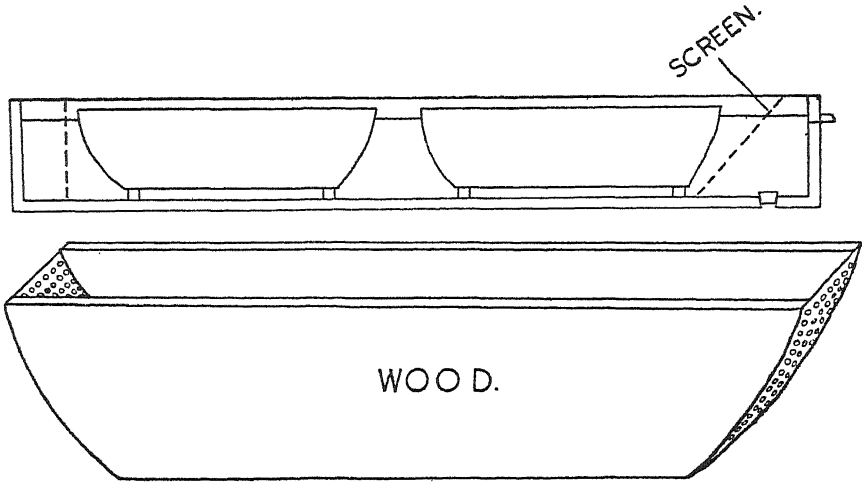


FIG. 8.—Upper: Hatching trough fitted with trays.
Lower: Hatching tray.

upward filtration tank, as shown in Fig. 7, is easily and economically constructed. Such a tank must be scoured periodically.

The hatching troughs are box-shaped and made of wood. The

water is led in at one end and flows out at the other, the depth being regulated by a small sluice which is guarded by a perforated zinc stop to prevent the escape of alevins. Although one large trough may be used, a number of small troughs 3ft. by 1ft. by 6in. deep, arranged in series, will be found more useful. Each small trough is fitted to carry two boat-shaped trays, constructed of wood and zinc gauze, as shown in Fig. 8. The whole apparatus should be given three coats of bituminous varnish before use. When in use, these troughs should be placed on a firm base and covered with a light and vermin-proof lid.

A gentle current of water, strong enough to keep the water pure and aerated without moving the eggs, should pass through the trough. At Jonkershoek a flow of 3 gallons per minute is used for each series of troughs (see Fig. 7), but this is probably for more than is required. Mottram (22) advocates a flow of 10 gallons per hour per 3,000 eggs, but gives no details of water temperature. Leach (21) describes a very practical method of measuring streamflow:—

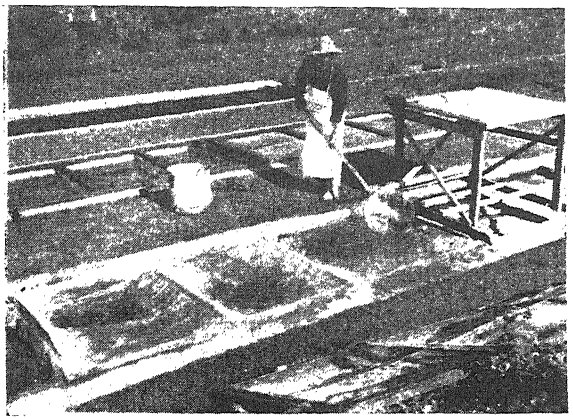
> With a wide board 1 inch thick and having a smooth 1-inch hole bored through the middle, a tight dam is made across the stream so that all the water will flow through the hole in order to escape. If the water above the board rises just to the top of the hole, it indicates a volume of 2.3 gallons per minute. A rise of one-half inch above the top of the hole indicates a volume of 3.5 gallons per minute; a rise of 2 inches, 5 gallons per minute; 13 inches, 12 gallons per minute. If two 1-inch holes are bored, twice the volume will be indicated in each case, of course. The quantity of water flowing through holes of different sizes is in proportion to the squares of their diameters. Thus, a 2-inch hole permits the passage of four times as much water as a 1-inch hole.

Stripping.

For many fisheries, both in Europe and America, it is a common practice to spawn the trout artificially. This obviates the heavy mortality of ova and alevins due to natural causes, and the fry obtained in this way can be distributed wherever they are needed.

The brood stock can be obtained by netting or trapping (see Plate V). It is comparatively easy to net the adults when they are on the spawning beds, but this necessitates the daily observation of the river. In large rivers a seine can be used, but in small side streams a hand net is more effective. This is placed across the stream at a suitable point and the fish driven down into it. The use of traps in small tributary streams which trout are known to ascend for spawning is another way of securing brood stock. This method is particularly effective in the feeder streams of reservoirs and is the means by which spawners are obtained for the Pirie Hatchery. The disadvantage of this method is that the fish obtained are usually unripe and have to be kept for some days to ripen off, whereas those taken from the spawning beds are usually ripe.

The artificial spawning of trout (stripping) is not very difficult where the correct apparatus is available. Three tanks provided with running water are required—one for ripe females, one for males and the third for the spent fish. Besides these, stripping basins approximately 6 inches in diameter and nets are necessary. The procedure is roughly as follows. Net a hen and hold her in the net until she has exhaused herself. Grasp her firmly above the tail with the left hand in such a manner that the arch between the thumb and the first finger closes tightly over the back. The right hand is placed at a level with the pectoral fins (see Plate VI).





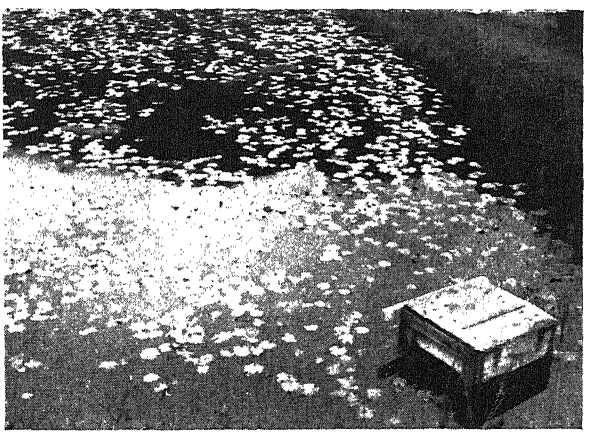


PLATE V.—Sorting trout for stripping. PLATE VI.—Stripping trout.
PLATE VII.—Lydell nesting box.

By gripping gently, bending the fish back and at the same time sliding the hand gently down the abdomen, the eggs will flow into the stripping basin if the hen is ripe. Should the eggs fail to flow freely, without undue pressure, the hen should be kept and stripping repeated in two or three days' time. In some instances a fish may, by muscular contraction, retain its eggs for a few seconds, but if the eggs are ripe they will begin to flow as soon as the muscles relax. By holding a cock fish in the same way and exerting a little pressure about half-way down the side with the forefinger, a little milt is exuded over the eggs. Eggs and milt are then thoroughly mixed by stirring with the forefinger and the mixture is allowed to stand in the cool for five minutes. It is then washed by decantation and placed in a large basin, under water, until the eggs are no longer sticky. They may then be placed in the hatching boxes or trough. All the females are stripped in this manner, the process being repeated twice a week until no more eggs can be obtained. The fish may then be replaced in the river after a rest of twenty-four hours in the tank.

The most convenient method of hatching large numbers of eggs is in hatching troughs. For smaller quantities, the floating hatching box may be employed. For the first twelve to tweny-four hours after extrusion, the eggs are very hardy and can be handled with impunity. From then onward until the eyes of the developing embryo become visible, they are extremely sensitive to jarring or sudden changes of temperature. It is necessary to examine the eggs daily and to remove the dead ones. When an egg dies it usually turns white. It is no longer able to control the osmotic processes, water penetrates the egg and coagulates the albumen. After about 14 days in the case of rainbow trout and 21 days in the case of brown, at a water temperature of 12° C. (54° F.), the eyes of the developing embryo become visible as tiny black spots in the egg. At this stage they should be placed in a small net and washed in running water, when any unfertile eggs will turn white. The eggs are then examined in a shallow white basin (photographic developing dish) under a strong light, when eggs containing defective embryos will be clearly visible and can be removed. The remaining eggs are then ready for distribution by post or rail, or they may be allowed to hatch.

During the absorption of the yolk sac the alevins lie quietly on the bottom of the tray, but as soon as this process is completed, they leave the bottom and support themselves in the water. At this stage they must be transferred to the river, as the artificial feeding of trout fry requires the supervision of an expert pisciculturist. The fry are most conveniently removed from the trays by siphoning them through a 1-inch bore rubber tube. Large milk cans are the most convenient containers for the distribution of fry.

Stocking with Trout Fry.

In cases where it is impracticable to hatch trout ova, fry may be obtained from either of the Government Hatcheries at the following rates:—

Trout fry under two months old	£3	0	0	per 1,000
Trout fingerlings (± 3 inches long)		12	6	per 100
Trout yearlings	£1	0	0	per 100

Although a very convenient method of stocking, there are a number of grave disadvantages attendant on the use of hatchery fry.

1. They cannot be transported long distances and therefore their range of distribution (considering present-day facilities) is within a twelve-hour journey of the hatchery.
2. The longer they are artificially fed, the more difficulty they experience in obtaining food under natural conditions.
3. They fall an easy prey to anglers and predators alike.

In order to minimise the latter two disadvantages, a novel method of stocking has been employed with great success in America (Hewitt, 11). By the construction of a weir (as described in Part 1), a pool is formed in the side stream of the river it is intended to stock. The weir should be practically watertight and provided with a screened outlet and scour valve. About 10,000 fry to the acre are planted. These fish are not fed at all and must fend for themselves. If conditions are suitable, the fry should grow rapidly and become strong trout capable of looking after themselves in the main river. At the end of the year, the pond should be drained and the fry allowed to escape into the river through the scour valve. In America, a pond of this nature stocked with 10,000 brook trout fry, produced 3,540 four-inch fingerlings at the end of one year.

Trout Culture for Culinary Purposes.

For this purpose any small dam, cement pool or circular reservoir can be used, provided that the water supply is suitable and adequate (1,000 gallons per hour). Furthermore, the water must be clear, cool and fairly pure. The temperature of the water is the most important single factor and should not exceed 23° C. (73° F.).

The draining, cleaning, disinfecting and screening of such ponds for fish culture has already been described (Part 1). If the pond is larger than half an acre, there will be sufficient natural food for 100 fry or fingerlings. Where this is not the case, the fry may be fed on mashed liver, spleen, heart, brain or kidneys. This is prepared by removing all hard parts and fat and forcing the remainder through a fine screen or pulverising it with the blade of a knife, much as putty is mixed. In all cases only fresh, hygienic food should be used. The fish are fed by throwing small amounts of food into the intake stream until they no longer feed readily. Food should not be allowed to decay on the bottom of the pond, and therefore excess feeding should be avoided. Dead fish should also be removed.

As the fish grow, the size of the food particles should be increased. At this stage it is best to prepare the food in a small mincing machine, using 2 to 4 mm. apertures. The meat may now be mixed with a little cooked flour or potato, and occasionally a small quantity of lime should be administered. When the fish become larger, the apertures in the mincing machine may be increased to 1 cm. All fats should be strictly avoided and the adults should not be fed during hot spells. At such times they may be given a little food in the cool of the evening. Whenever possible, the fish should be given natural food in the form of tadpoles, small crabs, small fish and earthworms to compensate for the deficiencies in a pure meat diet. As soon as the fish have grown to the requisite size, they may be netted from the " stew " pond as required. Besides being a useful stand-by in times of need, fresh trout is a welcome addition to any table.

Stocking with Bass.

Either species of smallmouth bass fingerlings may be obtained from the Jonkershoek Trout Hatchery at 2s. 6d. each and are liberated in the same manner as described for trout. It is obvious, however, that a few dozen fry would make very little impression on a river. Even if they did establish themselves, it would take many years before they were present in sufficient numbers to be of any use for angling or commercial purposes. Consequently, the following, more economical and very efficient, method of stocking is advocated. As already stated, although essentially river fish, smallmouth bass will breed in ponds of about an acre if an adequate water supply is available. Since they cannot be stripped, the fish are allowed to breed and rear their young in the natural way. After the fry have grown to a suitable size, they are distributed. A normal adult black bass produces from five to ten thousand eggs and as losses to the fingerling stage should not exceed 50 per cent., the efficacy of this method of stocking needs no emphasis.

The pond is prepared as described in Part 1. Brood fish are obtained by allowing a few dozen hatchery fry to grow to maturity in the pond or by obtaining wild adults on a hook and line or by means of nets. The latter should be caught in the autumn so that they may become accustomed to their new quarters by the spring. Brood stock caught in spring often refuse to breed in strange surroundings. About 24 breeders are sufficient for a pond of an acre and there should be more females than males.

The use of a hook (barbless) and line is the best and easiest method of obtaining brood stock. The fish should, however, be handled as little as possible and then only with wet hands. In order to avoid injury from the sharp dorsal spines, the bass can be handled safely by holding the lower jaw between the thumb and forefinger. This will also prevent injury to the fish during its struggles. Although it is difficult to distinguish the sexes, except immediately in advance of the spawning season, males and females are usually caught in about equal proportions.

Large receptacles should be used for transporting brood stock, and the water must be cool and pure. Ten-gallon milk cans, clean drums, or a tarpaulin roughly fitted on to a frame are all suitable. New galvanised metal is to be avoided and all containers must be scrupulously clean. They should be only two-thirds full of water and covered with special covers or sacking while in transit, to prevent the fish from leaping out. Special covers should be perforated to provide aeration of the water. Exposure to the sun should be avoided and the water should be kept as cool and well aerated throughout the journey as possible. During transit, the splashing of the water will effect this, but when stationary adequate aeration of the water can be ensured by taking a dipper of water from the container and pouring it back from a height of about two feet.

Before liberating the brood stock into the spawning pond, temperatures of the pond water and the water in the containers should be ascertained. If any appreciable difference exists, water from the containers should be replaced, a little at a time, by water from the pond, until the temperatures are equalised. Even if there is no difference in temperature, it is good practice to make the change gradually, since the difference in the mineral and gaseous contents of different waters may sometimes be so great that too sudden a change might prove harmful.

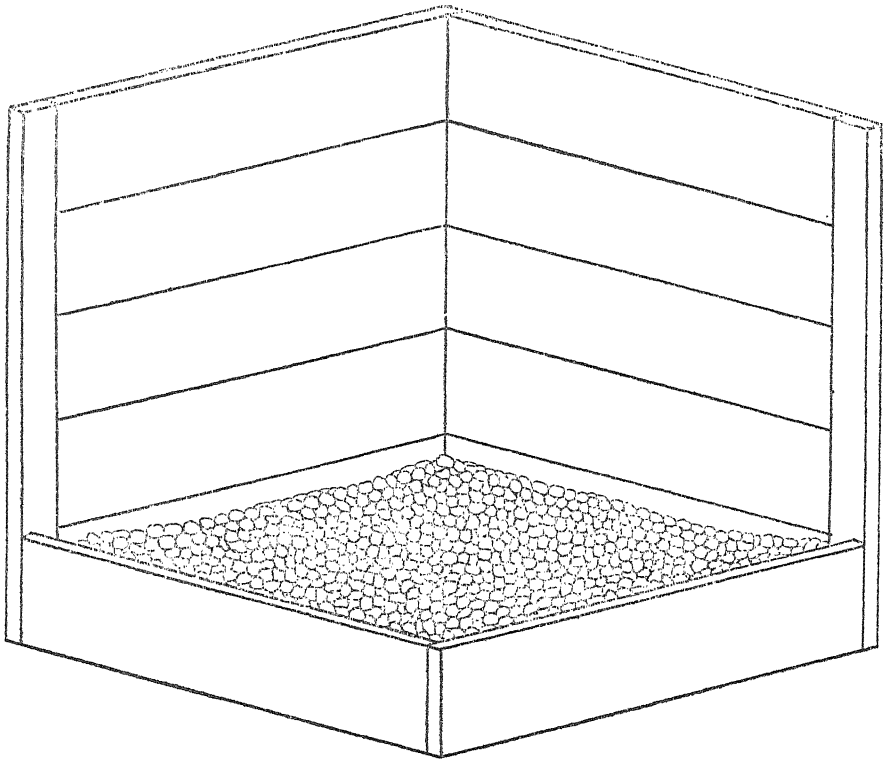


FIG. 9.—Lydell nesting box.

For smallmouth bass artificial nesting boxes should be used, as this species will only spawn on clean gravel. These are not required for spotted bass, which will spawn on the hard bottom or among the roots of aquatic vegetation. The "Lydell" nest is one of the most commonly used and should be placed in position a few months before the breeding season. It is in the form of a cubical box, without bottom or top. Two contiguous sides are approximately 4 inches, while the other two are 16 inches high, and the whole is constructed of flooring board throughout, as shown in Plate VII and Fig. 9. An adequate number of nesting boxes should be provided and placed parallel to the shore in water about two feet deep, the two sheltered sides facing the bank. The frames are filled with gravel to the upper edge of the lower sides. The gravel should consist of pebbles 2 to 3 inches in diameter with an admixture of finer gravel and sand. A wide board is placed across the angle formed by the two high sides and the whole is weighted down with a large stone.

After the bass have spawned and the fry are free-swimming, as many adults as possible should be removed from the pond, to reduce losses resulting from cannibalism. This is best done with a hook and line. A careful watch should also be kept for predators as these will take a tremendous toll of the fry in such a confined space.

From this stage, the fry may be left to their own devices and, provided that the pond has been properly fertilised, they should be 4 inches in length within three months. This is a convenient size for distribution

and they may be netted from the pond as required. In this way a river can be stocked with thousands of healthy, virile fingerlings as opposed to the haphazard method of planting a few dozen hatchery fry.

The Care and Management of a Fishery

The improvement of streams to create a fishery has already been described (Hey, 16) and therefore this chapter will only deal with the maintenance of such fisheries. This, in broad outline, consists of conserving the natural resources, re-stocking, maintaining spawning facilities and controlling the predators.

The preservation of existing forests or reforestation is of general benefit to a fishery. Forests on watersheds and in stream valleys help to minimise the disastrous effects of droughts and floods by equalising the streamflow. The shade provided by the trees prevents excessive summer heating of the water, thus producing conditions resulting in a more constant food supply. Phillips (26), in New Zealand, concludes his examination of certain river systems by saying " that owing to various causes, the fauna of our waters has been seriously depleted in many parts of the Province, and that if no steps are taken to combat it, the situation will worsen progressively. That deforestation has been the main factor in creating this deficiency, for it is most marked where the stream banks have been denuded of vegetation, and that this applies mainly to fast flowing waters."

The farmer can also assist in conserving catchments and preventing floods. The construction of contour furrows on overgrazed hill-slopes, prevention of further overgrazing and the planting of suitable grasses are all means towards this end. The conservation of natural lakes and swamps in a valley must naturally aid in preventing extreme fluctuations, thus ensuring a more steady supply of water in the lower valley.

Although restocking, which is essential in waters where natural spawning grounds are not available, usually yields good results, it may, under certain conditions, prove disastrous. If fish are placed in waters already fully stocked, the food supply will be reduced, and a general falling-off in the condition and rate of growth of all the fish will follow. Consequently, the approximate number of fish per mile of river should be determined, if possible, before restocking is undertaken. An understocked river is characterised by a small number of well-conditioned rapidly growing fish, whereas an overstocked water contains many stunted, poor conditioned fish.

It is a well-known fact that the age and rate of growth of a fish can be read from rings on the scales much as the age of a tree can usually be determined from the rings on the stump. Scale studies to determine rates of growth are of fundamental importance as an aid in developing stocking policies as they serve as a guide for further plantings.

The scales of young bass are circular, but later an unequal growth of the anterior margin produces the characteristic cycloid or ctenoid shape, as shown in Fig. 10. A typical scale is divided into an anterior field, a large transparent area covered in life by adjacent scales, and a posterior field which bears the outer pigmented epithelium. Medially between the two fields is the nucleus, or focus of the scale, the point of initial growth. As the scale grows, circuli or growth-rings form concentrically about the nucleus in much the same manner as growth takes place in a tree. During summer when growth is rapid, the circuli are wide apart, but in winter when growth is retarded, the circuli are very close together and appear

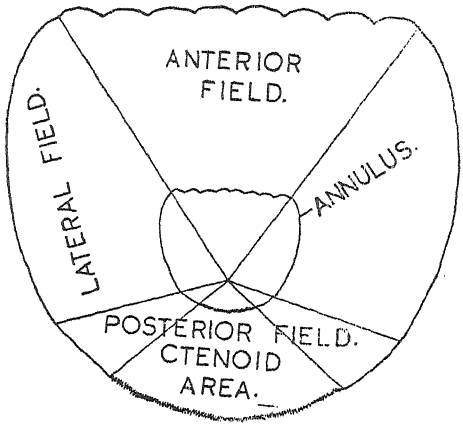


FIG. 10.—Orientation diagram of a black bass scale, showing position of first annulus (partly after Harrison).

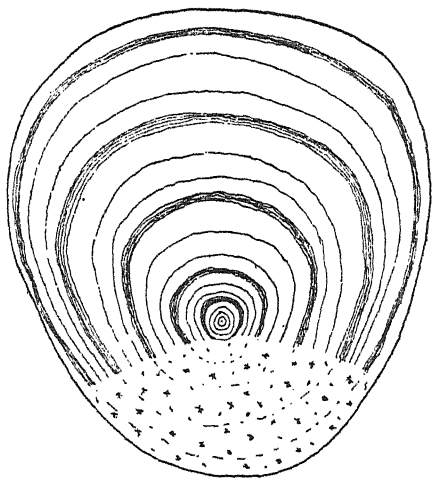


FIG. 11.—Diagram of a trout scale, showing crowding of circuli to form annulus.

under an ordinary hand lens as a band or annulus. This crowding of the circuli to form an annulus or year mark becomes more apparent as the fish grows older. Where we have retarded growth in summer caused by food shortage or other factors, false annuli may be formed. The age of the fish may thus be estimated by counting the number of annuli. Where the space between two successive annuli is large we can assume that the fish in question enjoyed a good season, where small that the feeding is poor and the fish consequently stunted.

Scales removed for examination should be taken from the area between the mid-dorsal and lateral line just posterior to the head. By placing them

on a glass slide and holding it against the light, the annuli will be visible through a good pocket lens (see Fig. 11).

As compared to those of bass, the scales of trout are small and deeply bedded in the skin. They can, however, be read in the same manner. Readers interested in obtaining further information on this subject are referred to the works of Harrison (8) and Creaser (3).

Restocking with new species is always dangerous unless it is definitely known that the species present in the water is unsuitable and is giving unsatisfactory results. One of the worst features of this type of restocking is that it is often apparently highly successful. Fish introduced in this way lack the normal population checks found in their native environment and will often grow and reproduce at a high rate. As soon as their food supply is reduced, they become cannibals, and there finally results a large population of stunted fish of poor food and sport value.

In every case where the species in the river is not successful, conditions should be examined carefully to determine the reason, or, in the case of virgin waters, the most suitable species for stocking. In the former case, far better results will usually be obtained by improving existing conditions than by restocking. In many instances, extensive restockings are undertaken with the object of introducing fresh blood. Experiments have proved beyond doubt that there is little value in fresh blood. There is, however, great value in good blood, and this can be obtained by selecting the breeding stock.

Spawning beds should be maintained in a silt- and mud-free condition. The most useful tool for this is a long-toothed rake. The upper waters and small tributaries of a stream are the most suitable breeding grounds. The farther upstream the parent fish go, the safer the fry will be when they hatch, since these gravelly streams are too small to contain large cannibal fish. They are, therefore, the natural nurseries of the fry.

In small streams with occasional large pools, an odd big trout is sure to be found. These are cannibals and are best out of the water. They never rise to a fly and therefore should be caught with worms. Eels are also a menace in smaller rivers. Apart from the fact that they destroy ova and alevins, they consume a great deal of valuable trout food. They may be trapped or caught with worms. The control of bird predators, however, is a rather delicate question and one on which much diversity of opinion exists. In this category have been listed herons *(Ardea sp.)*, cormorants *(Microcarbo* and *Anhinga)*, dabchicks *(Poliocephalus)*, hamerkops *(Scopus)* and kingfishers *(Megaceryle)* (Roberts, 28). There is no doubt that they do considerable damage at fish-cultural stations and that control measures are needed, but stomach examinations of fish-eating birds by workers of the Division of Wildlife Research of the U.S. Bureau of Biological Survey (Needham, 23) have shown that along the average open trout stream or lake most of their food consists of non-game species, which are easier to catch than bass or trout. Kingfishers, in particular, are not very harmful as they feed to a large extent on crabs. A trout stream without a kingfisher or two would be a dull place. Much destructive and misguided conservation work has been done in indiscriminate campaigns to destroy so-called fish predators.

LITERATURE CITED.

1. 1933. BUSH, S. F.: The Establishment and Well-being of Trout in Natal Waters: An Ecological Problem. *S. Afr. Journal of Science.* Volume XXX, p.p. 366-387.

2. 1930. CREASER, CHARLES W.: Relative Importance of Hydrogen Ion Concentration, Dissolved Oxygen and Carbon Dioxide Tension on Habitat Selection of Brook Trout. *Ecology*. Vol. II, No. 2, p. 246.
3. 1926. CREASER, CHARLES W.: The Structure and Growth of the Scales of Fishes in Relation to the Interpretation of their Life-History, with special reference to the Sunfish *Eopomotis gibbosus*. Misc. Pub. No. 17, Univ. of Mich., Ann Arbor, Michigan.
4. 1921. EMBODY, G. C.: High Water Temperature and Trout. *Salmon and Trout Mag.*, No. 44, p. 290.
5. 1939. FROST, W. E.: The Food Consumed by Brown Trout *(Salmo trutta Linn.)* in Acid and Alkaline Waters. *Proc. Roy. Irish Ac.*, Vol. XLV, Sect. 8, No. 7.
6. 1932. GREELEY, J. R.: The Spawning Habit of Brook, Brown and Rainbow Trout and the Problem of Egg Predators. *Trans. Am. Fish. Soc.*, Vol 62, p.p. 239-248.
7. 1940. HARRISON, A. C.: The Acclimatization of Freshwater Game Fish. *Jour. S.A. For. Assn.*, No. 4.
8. 1934. ————: Black Bass in the Cape Province. Investigational Report No. 4, Govt. Printer, Pretoria.
9. 1939. ————: The Importation of American Smallmouth Bass. Cape Piscatorial Society, Circular No. 28.
10. 1939. ————: The Importation of Spotted Bass. Cape Piscatorial Society, Circular No. 34.
11. 1926. HEWITT, E. R.: Telling on Trout. Charles Scribner's Sons, London.
12. 1926. HEY, S. A.: Fisheries Survey of Inland Waters. Reports 1, 2 and 3. Govt. Printers, Cape Town.
13. 1940. HEY, D.: A Preliminary Report on the Reproduction of Trout in the Steenbras Reservoir. Cape Piscatorial Society, Circular No. 35.
14. 1940. ————: A Further Report on the Low Fertility of Trout Eggs at the Jonkershoek Trout Hatchery. *Annals of the University of Stellenbosch*. Vol. 18, Section A, No. 1.
15. 1941. ————: Some Ecological Factors affecting the Fertility of Trout Eggs at Jonkershoek Trout Hatchery. *Transactions of the Royal Society of S.A.* (In the Press.)
16. 1941. ————: The Establishment and Maintenance of Freshwater Fish in South Africa. Section 1. Improvement of Dams and Streams. *Jour. S.A. For. Assn.* No. 6.
17. 1940. HOBBS, D. F.: The Natural Reproduction of Trout in New Zealand and its Relation to Density of Populations. Fisheries. Bull. No. 8. Marine Dept., New Zealand.
18. 1940. HUBBS, CARL L., AND M. REEVE BAILEY: A Revision of the Black Basses *(Micropterus* and *Huro)* with Descriptions of Four New Forms. University of Michigan Press, Ann Arbor.
19. 1924. JONES, S. R.: Black Bass and Bass Craft. The Macmillan Co., New York.
20. 1914. KROGH, A.: The Quantitative Relation between Temperature and Standard Metabolism in Animals. *Intern. Zeit. Physik-Chem.* p.p. 491-508.
21. 1939. LEACH, GLEN C.: The Artificial Propagation of Brook Trout and Rainbow Trout, with Notes on Three Other Species. Fisheries Document No. 955. U.S. Dept. of Interior.
22. 1928. MOTTRAM, J. C.: Trout Fisheries. Herbert Jenkins, Ltd., London.
23. 1940. NEEDHAM, PAUL R.: Trout Streams. Comstock Publishing Co., New York.
24. 1916. NEEDHAM, JAMES G., AND J. T. LLOYD: The Life of Inland Waters. Comstock Publishing Co., New York.
25. 1920. PEART, A. R.: The Mechanics of Fertilisation in Trout. *S. & T. Mag.*, No. 21, March.
26. 1929. PHILLIPS, J. S.: A Report on the Food of Trout. Fisheries Bull. No. 2, New Zealand Marine Dept.
27. 1904. REIGHARD, J.: The Breeding Habits, Development and Propagation of the Black Bass. Bull. 7 of the Michigan Fish Commission.
28. 1940. ROBERTS, A.: The Birds of South Africa. The Central News Agency, Johannesburg.

29. 1920. SMOLIAN, K.: Merkbuch der Binnenfischerei, Band 2. Denter und Nicholas, Berlin.
30. 1929. TRAVENER, E.: Trout Fishing from All Angles. Seeley, Service & Co., Ltd., London.
31. 1931. VIOSCA, JR., PERCY: The Southern Smallmouth Black Bass *(Micropterus pseudaplites)*. Hubbs. *Trans. Am. Fish. Soc.*
32. 1941. WORTHINGTON, E. B.: A Report on Attempts to Acclimatise Rainbow Trout in Britain. *S. & T. Mag.*, Nos. 100 and 101.

DIURNAL FLUCTUATIONS IN JONKERSHOEK STREAMS DUE TO EVAPORATION AND TRANSPIRATION

By C. L. WICHT

(Forest Research Officer, Jonkershoek.)

THE flows of perennial streams at the Jonkershoek Forest Influences Research Station are being recorded, in order to determine how they will be influenced by afforestation, veld-burning, grazing and protection of natural vegetation. Records of streams so far analysed show diurnal fluctuations during warm rainless weather, which are due to evaporation and transpiration losses of water from the streams and their banks. The fluctuations indicate that on warm dry days certain volumes of ground-water, which would normally have seeped into the streams, fail to reach them, or are drawn out after having passed into the streams. This loss of water may be accepted as an indirect relative measure of the daily volume of water returned to the atmosphere from the streams and the drainage areas adjacent to them. When the system of management applied within a catchment is changed, its effect on this daily water loss will, therefore, show whether the consumptive use of water along the stream course has been increased or decreased.

At Jonkershoek it will be possible to contrast the effects of natural stream-bank vegetation with those of exotic pine trees, and with the effects of broadcast burning (Wicht, '39). Natural vegetation along the streams *Langrivier* and *Lambrechtsbos-A* will be protected permanently. In *Abdolskloof* it will be burned periodically. In *Biesiesvlei* it will be replaced by exotic trees after a period of protection. The *Bosboukloof* and *Eersterivier* catchments will be afforested to within sixty feet of streams. In *Lambrechtsbos-B* and *Tierkloof* veld-burning will be carried out to within sixty feet of streams. *Tierkloof* is to be afforested after observations have been conducted for twenty-six years. A preliminary analysis of diurnal fluctuations in the streams *Bosboukloof, Abdolskloof, Biesievlei, Tierkloof* and *Langrivier* is presented in this paper. It is intended to serve as a basis for further analyses which will be made later to determine the effects of the changes in the managements of the catchments.

Hydrological Features of Jonkershoek Catchments and Streams

The experimental catchments are situated in a mountainous region within the humid, temperate, winter rainfall climate which is typical of the south-western Cape (Wicht, '40). They all lie within five miles of each other, but are hydrographically different. They vary in size from about fifty acres to well over 10,000 acres. In the smallest catchment the change in altitude is little over 100 feet; in some of the larger ones it is over 4,000 feet. Rainfall, atmospheric humidity and temperature

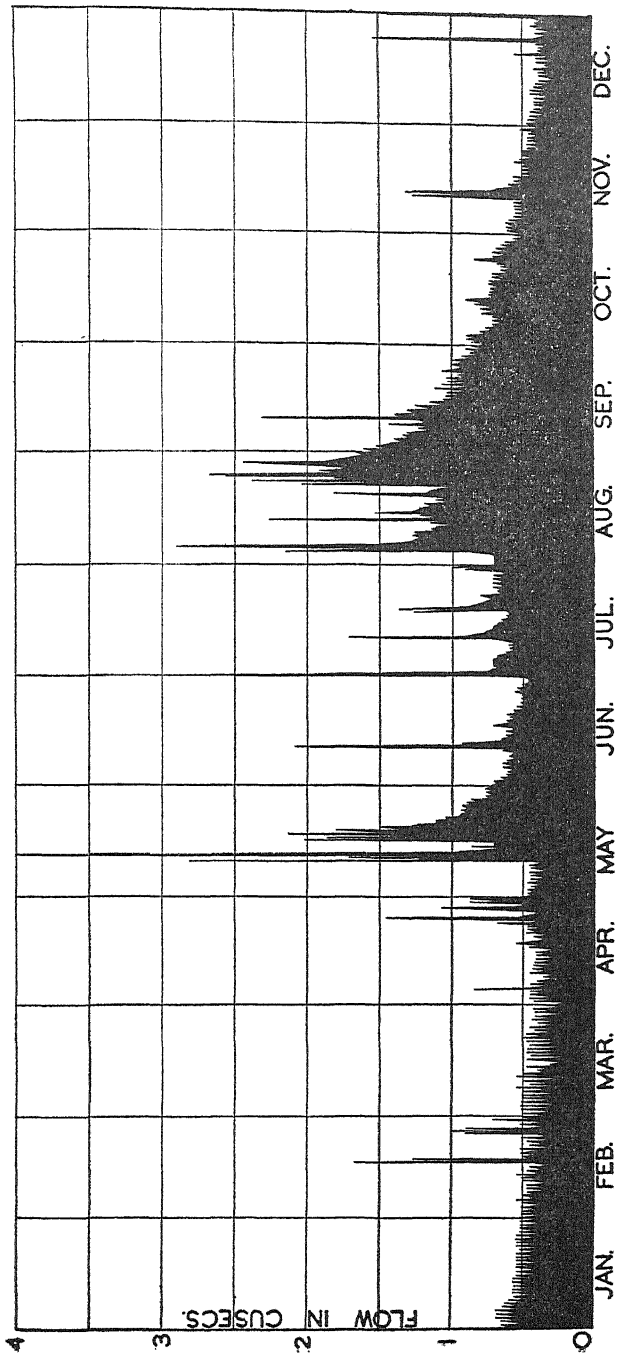


Fig. 1.—Hydrograph Bosboukloof, 1939.

show considerable fluctuations. Variations in vegetation are associated with these and with differences in geology, soils and topography. In general, the natural vegetation is sclerophilous shrub, comparable in some respects to the "chaparral" of California, the "Mâquis" of the Mediterranean coasts, and the vegetation in similar climates in western and southern Australia and in Chili, South America. The plant growth has been modified in the past by veld-burning and grazing. In moist localities along some streams there are negligible remnants of broad-leaved evergreen indigenous forests, which may have been much more extensive in the past. The shrub vegetation along streams is more luxuriant than elsewhere, and moisture-loving plants appear. Owing to the mildness of the climate these stream-bank plant communities never have a period of complete rest. Because there is always a supply of ground-water, transpiration never ceases. Floristically, the variation is considerable and the number of species represented is very large. All streams in Jonkershoek are well shaded by natural vegetation.

Variations in streamflow or surface run-off reflect the hydrographic characteristics of the catchment areas from which the streams emerge. Because the Jonkershoek streams all flow from relatively steep mountains within one climatic region, however, their annual hydrographs (Horton, '35), showing all fluctuations in flow over time, have certain general features in common. The hydrograph for *Bosboukloof*, 1939, reproduced in Fig. 1, is, therefore, to some extent typical of all Jonkershoek streams, in spite of the considerable differences in details between the catchments and the streams which emerge from them. In the dry summer months—November to March—the flow is at its lowest. In the rainy winter months—May to September—the general levels of the streams rise. After each rain there is an almost immediate rise and subsequent fall, or spate in the flow. These spates, shown as long thin points in Fig. 1, comprise stormflow, which is that portion of storm water which exceeds the infiltration capacity of the ground and enters the stream from the ground surface within a comparatively short time (Trans., '36, p. 302). In Jonkershoek stormflow contributes only a small percentage to the total annual yield of streams. The rest is yielded by ground-water flow, by which the streams are maintained after spates, until rain again occurs. This flow is derived from that portion of precipitation which has been absorbed by the ground and has become part of the ground-water, ultimately being discharged as spring and seepage-water into the stream-channels (Trans., '36, p. 302). Ground-water flow diminishes according to characteristic depletion curves (Horton, '35). These curves are not smooth at Jonkershoek, however, but show diurnal fluctuations. Such fluctuations have been indicated in Fig. 1, notably in the dry months such as January and March. They are also shown in the portion of the hydrograph for *Bosboukloof*, 1939, reproduced Fig. 2.

The streams from the various catchments differ mainly in the total yield of surface run-off, the rate at which the ground-water flow is depleted, the steepness and height of spates, the proportions of storm- and ground-water flow delivered, and, as will be shown in this paper, in the degree of diurnal fluctuations during rainless periods.

Implications of Diurnal Fluctuations

The time of occurrence, trend and extent of daily losses of water from streams during dry weather, indicate that they are caused by

evaporation and transpiration. It is not, however, easy to determine the relative amounts of loss which should be attributed to these two processes respectively.

In the *Rappengraben* experimental catchment at Emmental in Switzerland, Arnold Engler (Engler, '19) observed that during hot dry weather the flow decreased between upper and lower gauging stations on the same stream. He pointed out that this decrease could occur only if a volume of water greater than the volume passing into the stream from ground-water seepage along this stretch had been lost. During cool weather the flow was increased by seepage. The *Rappengraben* was lightly afforested. In the adjacent heavily wooded *Spergelgraben* no decrease in flow between similar gauging stations was observed. From this Engler concluded that the loss of water was mainly due to evaporation from the stream bed. Such evaporation, he contended, would be much diminished by the shading of trees in the wooded catchment. American research workers, on the other hand, have come to the conclusion that the losses are mainly due to the volume of water transpired by the stream-bed vegetation.

Observations at Santa Ana Valley, California.

The problem has been intensively investigated by Blaney, Troxell and Taylor in the Santa Ana Valley in California. Blaney (Blaney, Taylor and Young, '30) established two streamflow recording stations on the *Temescal Creek* and observed that the flow decreased between the upper and lower stations, until it finally dried up completely at the lower point. His records also showed diurnal fluctuations in flow, which occurred almost simultaneously at both stations. In the *Temescal Creek* very special conditions prevailed. The drainage area, on both sides of the length of stream investigated, was so dry that no ground-water seepage was added to the stream along this section. The difference in flow between the gauging points could, therefore, be used to estimate the total consumptive use of water along this section of the stream, after an allowance had been made for under-flow at the lower gauging station. This allowance was made by assuming that the evaporation-transpiration losses in the early morning would be very low, so that the decrease in flow observed at that time would be almost entirely due to under-flow. Investigations with double streamflow recording stations were later extended to *Coldwater Canyon* (Hoyt and Troxell, '34, p. 44; Taylor, '34), and the *Santa Ana River* (Troxell, '36), where analogous water losses were observed.

In support of Blaney's streamflow observations the evaporation-transpiration losses from tanks planted with various stream-bank plants were measured. Investigations with such tanks have been developed mainly by Taylor (Taylor, '34). The trend of the losses from tanks were shown to agree closely with the trend of temperature changes. The lowest points of the diurnal fluctuations in streamflow occurred several hours later than the times of maximum evaporation-transpiration and temperature, however. Blaney attributed this delay, for the *Temescal Creek* area, to be the speed with which the general draft on the water table was compensated for by water drawn from the stream channel. This explanation implies that the fluctuations in the streams were principally due to the effects of transpiration by the plant growth along the stream bed, because evaporation from the water table could only have been relatively low.

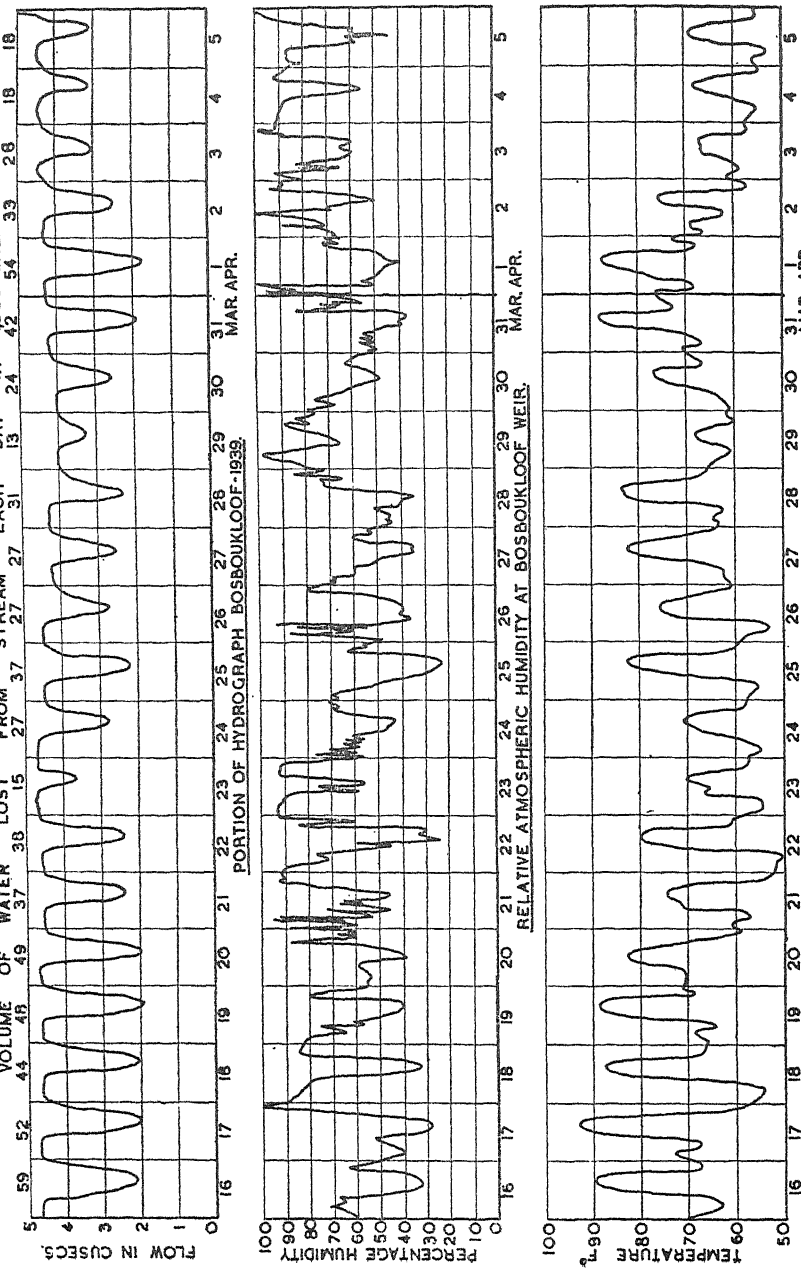


Fig. 2.—Portion of hydrograph Bosboukloof, 1939, with associated humidities and temperatures.

A most valuable study of diurnal fluctuations has been contributed by Troxell (Blaney and Troxell, '34; Troxell, '36). He found, by observing the water table level in wells, that fluctuations were not confined to streams, but that they occurred also in the ground-water table adjacent to the streams. This fact clearly supports Blaney's hypothesis that the fluctuations are due to the draft on the water table by transpiring plants. Troxell has also shown that the general form, though not the extent, of the fluctuations is more or less similar in all streams examined by him, whatever the hydrographic characteristics of the catchments were from which the streams flowed. All streams reached maximum flow at about ten o'clock in the morning and the minimum late in the afternoon. According to him the fluctuations did not progress downstream, but occurred simultaneously at all points.

Troxell carefully analysed the losses of water between streamflow recording stations along a stretch of the *Santa Ana River* (Troxell, '38). On the basis of these analyses he puts forward the hypothesis that the diurnal cycle "represents nothing more than an accumulative curve showing the difference between additions to and extractions from storage" (Troxell, '36, p. 504). Thus, according to this hypothesis, it may be deduced that as the water withdrawn daily from the immediate sources of water supply in the stream is increased, so the stream will drop. The sources of streamflow during dry periods are, firstly, ground-water from which water is withdrawn mainly by transpiration, and secondly, channel-storage from which water is withdrawn (a) by stream bed absorption to compensate for the drain on ground-water, (b) by direct evaporation from the water surface and from adjacent water-logged soil, and (c) by the transpiration of aquatic plants. Channel-storage (Horton, '35) represents the volume of water in stream channels above the gauging points at a given time. When the drains on ground-water adjacent to streams and the drains on channel storage are decreased towards the afternoon, the sources of supply are replenished by ground-water seepage from the higher parts of the catchment, until the original levels have very nearly been regained. Troxell's contention is, in effect, that streams fall when losses exceed replenishment, and rise when circumstances are reversed.

Observations at Jonkershoek.

Most of the conclusions reached by Blaney and Troxell have been confirmed by observations made at Jonkershoek. If the fluctuations shown in Fig. 2 are compared with the daily changes in atmospheric humidity and the daily temperature changes shewn, we find that hot days with low atmospheric humidity coincide with deep fluctuations, and cool days with high humidity show shallow fluctuations. These graphs also show that the lowest humidity reached daily occurs at about the time of maximum temperature, namely, at about three o'clock in the afternoon. The lowest levels reached by the streams occur at five o'clock, about two hours later. The general form of the fluctuations differs from that observed by Blaney and Troxell in one respect. The streams do not rise continuously to their maximum levels at ten o'clock the following morning. They approach a static head, which must be a point on the normal ground-water depletion curve, at about midnight, and then flow level or almost level until they fall again due to the evapo-transpiration losses at nine to ten o'clock next morning.

Observations at Jonkershoek show that fluctuations during dry summer periods are much greater than during dry winter periods (Fig. 1). This difference is doubtless due to greater warmth of summer weather, to the more rapid replenishment of water storage due to moister conditions in the catchment in winter, and to the generally lower transpiration in winter.

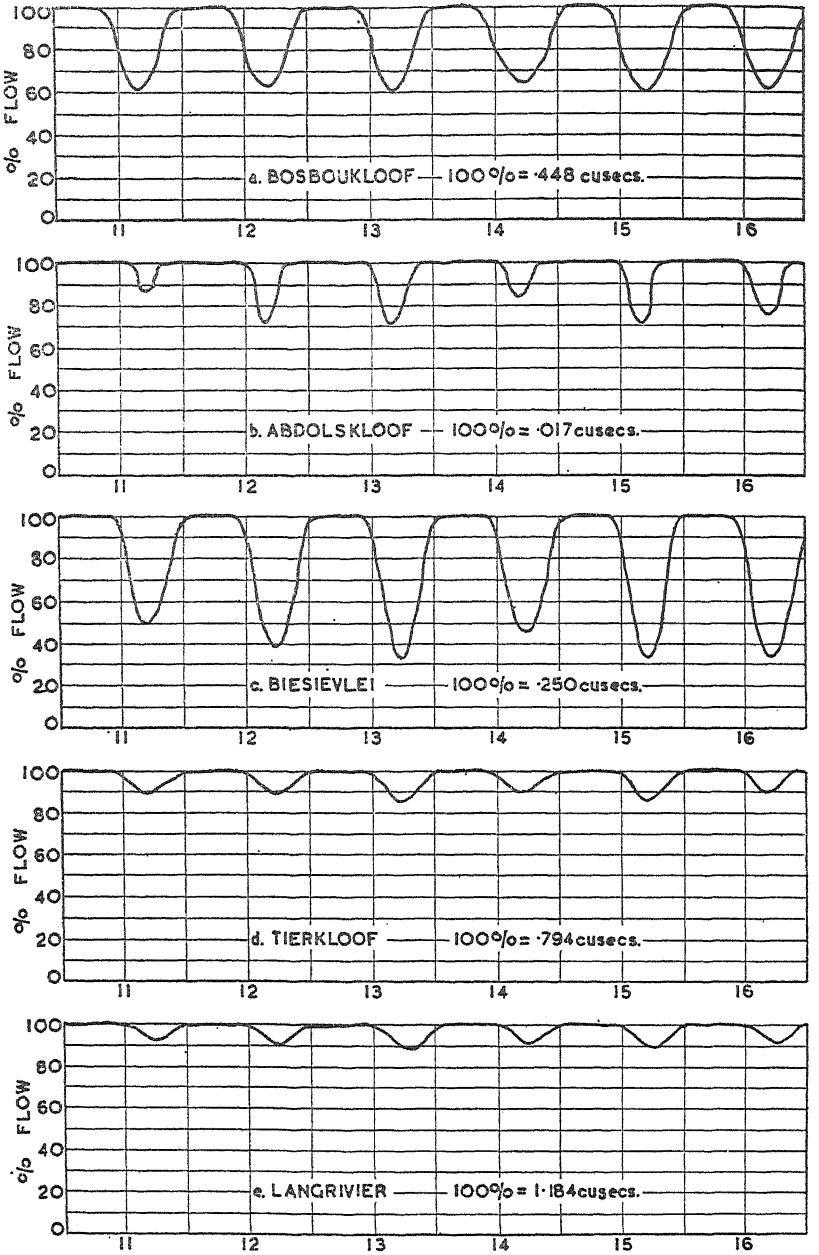


Fig. 3.—Relative diurnal fluctuations in Jonkershoek streams from 11th to 16th February, 1941.

In Fig. 3 the relative fluctuations in five streams are shown. The relative extent of the fluctuations is clearly characteristic of the individual streams. The *Bosboukloof* and *Biesievlei* catchments, showing deep fluctuations, are warm and sunny. The *Tierkloof* and *Langrivier* catchments are shaded by high mountain peaks to the north-east, and *Abdolskloof* also has a cool south-south-western aspect. The *Bosboukloof* and *Biesievlei* streams are smaller, slower streams than *Tierkloof* and *Langrivier*. Their catchments are less steep.

In order to test the reliability of the type of recorder used, accurate check readings of the levels of the *Bosboukloof* gauging pool were taken with a hook gauge. These showed that the rise and fall in the stream were slightly accentuated by a small amount of play in the recorder pen, but the error is too small to affect the results of these investigations of streamflow. It occurs in the records of all streams measured at Jonkershoek.

Interpretation of the Form of Fluctuations.

The mean fluctuations for the streams *Bosboukloof, Biesievlei* and *Tierkloof* in the year 1940 were calculated in order to examine their general form more closely. As can be seen from the hourly mean flows given in Table I, these are almost identical in form despite the considerable differences in the three catchments. The mean fluctuation for *Bosboukloof,* 1940, is also shown in Fig. 4.

TABLE I.

MEAN FLUCTUATIONS 1940

Time	Flow in Cusecs		
	Bosboukloof	Biesievlei	Tierkloof
6 a.m.	.662	.133	.760
7 a.m.	.663	.134	.761
8 a.m.	.663	.134	.761
9 a.m.	.662	.134	.761
10 a.m.	.652	.132	.755
11 a.m.	.637	.128	.746
Noon 12	.618	.123	.730
1 p.m.	.598	.115	.717
2 p.m.	.582	.110	.704
3 p.m.	.570	.106	.695
4 p.m.	.564	.104	.690
5 p.m.	.562	.103	.688
6 p.m.	.567	.104	.688
7 p.m.	.581	.107	.693
8 p.m.	.577	.113	.701
9 p.m.	.615	.119	.711
10 p.m.	.627	.124	.720
11 p.m.	.635	.127	.727
Mdnt. 12	.641	.129	.733
1 a.m.	.646	.131	.743
2 a.m.	.649	.132	.744
3 a.m.	.651	.132	.744
4 a.m.	.652	.132	.744
5 a.m.	.652	.132	.745
6 a.m.	.653	.132	.745

According to Troxell's hypothesis explained above, Fig. 4 is a mean cumulative curve showing the differences between additions to and extractions from storage. It is believed, however, that the form of the fluctuations can be explained more satisfactorily if it is accepted that the trend of the curve indicates, not the differences between additions

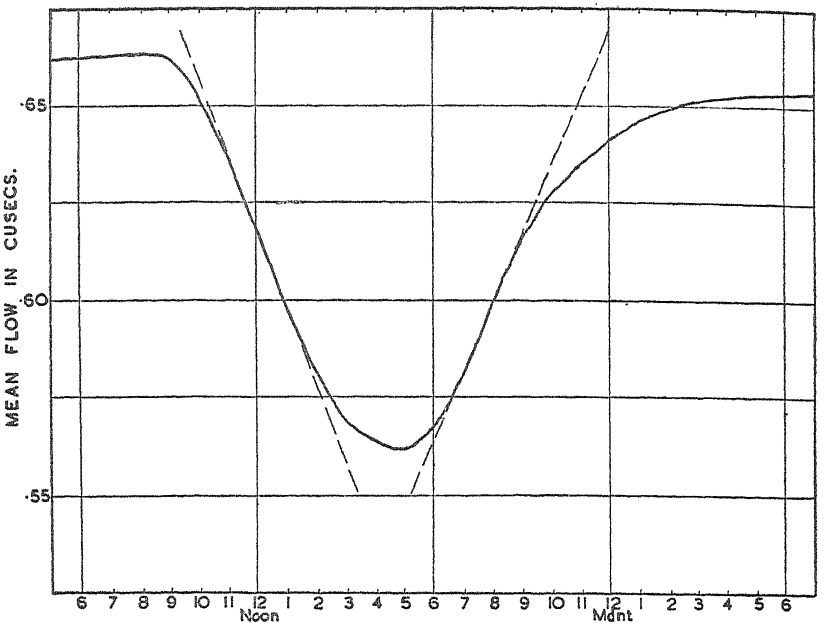


Fig. 4.—Mean fluctuation Bosboukloof, 1940.

to and extractions from storage, but the rate of change of such differences, and, further, that the effect of a change in the differences is delayed at the point of gauging. Storage should in this statement include ground-water adjacent to streams and channel-storage. Extractions include evapo-transpiration losses along the stream course and flow leaving the catchment at the gauging point. Additions, during dry weather, consist mainly of seepage from higher parts of the catchment.

The following interpretation of the mean fluctuation depicted in Fig. 4 is based on this modification of Troxell's hypothesis. Extractions began to exceed additions at about nine o'clock in the morning, due to the increase in evapo-transpiration losses, so that the stream level began to fall. This fall was immediate because it was started by losses immediately above the gauging point. The excess of extractions over additions increased rapidly over a period, which was reflected at the point of gauging, by a steep fall in the stream level from about eleven o'clock to about half past one (indicated by a broken line in Fig. 4). The maximum evapo-transpiration losses did not necessarily occur at this time, as supposed by Troxell (Troxell, '36). The steepest fall in stream-level reflects—after a lag—the maximum rate of increase in evapo-transpiration losses. The maximum evapo-transpiration losses over the stream length as a whole are reflected at the gauging point—after a lag—by the lowest level reached by the stream. After this, additions slowly begin to gain on extractions, and the steepest rise in stream-level (indicated by the second broken line in Fig. 4) reflects the maximum rate of decrease in evapo-transpiration losses. The slow rise of the stream-level then shows the delayed effect of the period when additions were gaining on extractions more and more slowly. As equilibrium was approached, the stream began to flow more nearly level. According to diagrams published by Troxell

the times of maximum fall and rise in the ground-water table and streams in the *Santa Ana Valley* agree with those recorded at Jonkershoek (Troxell, 36, Figs. 4 and 7). His diagrams of fluctuations in wells show that the steepest rises occurred just after six o'clock in the evening, and not at the time of lowest temperature in the early morning, as accepted by him.

No observations of the daily trends of evapo-transpiration losses are available from Jonkershoek at present, unfortunately, though it is hoped to supply these in future. The greatest acceleration in evaporation and transpiration may, however, be expected to occur in the morning, from some time after sunrise until some time before plants have reached their maximum rate of transpiration. The maximum losses will probably occur some time before the maximum temperature is reached between two and three o'clock. This may be caused by the closing of the stomata of plants while temperature is still rising, in order to prevent excessive losses of water. It may also be caused by incipient wilting. This may be the beginning of the period of the maximum decrease in evapo-transpiration losses, which would in such cases begin before three in the afternoon.

These possibilities make it appear likely that the effects of changes in evapo-transpiration losses are delayed at all stages of the diurnal fluctuations, except at the time when the stream begins to fall. Troxell has claimed that diurnal fluctuations do not progress downstream, but occur simultaneously at all points. This appears to be correct only in so far that they do not move downstream as a whole in the sense in which a single artificial wave does.

Troxell pre-supposes further that streams rise and fall much like long "pulsating reservoirs." The ground-water and channel-storage are, however, not still reservoirs, but moving volumes of water. A fall in level of stream — channel-storage — must, therefore, move downstream and affect the levels of the stream lower down. In he same way a fall in level of ground-water table must pass on and later affect levels nearer the stream, and ultimately the level of the stream itself. The diurnal fluctuations gauged in streams and wells are consequently compound depressions showing the delayed effects of numerous depressions in ground-water and channel-storage at various distances above the gauging station. This explains the lag in the lowest level reached and also the lag in occurrence of the points of steepest fall and rise.

The explanation offered here implies that the lowest points in ground-water level fluctuations do progress as the stream bed is approached, and that the lowest levels in streamflow fluctuations progress downstream. Further precise observations are required to establish this point. It can be shown, however, that such progress must be slow. Let us assume that the evapo-transpiration losses are directly proportional to the evaporation capacity of the atmosphere and that they increase to the time of maximum temperature—three o'clock at Jonkershoek—and then decrease. The lowest points of the compound fluctuations formed by delayed effects at the gauging point of such depressions will all fall within the hours four in the afternoon to seven in the evening, even if the average time taken to supply water from storage to gauging point varies from two to twelve hours. This statement may be tested by mechanically shifting such depressions along in time and calculating their combined effect at various periods after occurrence. Considerable variations in catchments

would, therefore, not prevent the lowest points of fluctuations from occurring in the late afternoon or early evening. Fluctuations in Southern California streams reproduced by Troxell (Troxell, '36, p. 497) in his first figure show that the lowest points in small catchments at high elevations occur before six o'clock in the evening. In the larger catchments at low elevations they occur after six.

The lag of the lowest points in a particular stream will depend on the average time taken for water to be supplied from storage to the point of gauging. This time is lengthened or shortened by a number of positive or negative influences. Thus, for example, in short, narrow, steep catchments delivering a relatively fast, strong stream of water from porous soils favouring rapid seepage, the lag will be short. In long, wide, flat catchments with relatively slow, weak streams where ground-seepage is slow, the lag will be long.

Streams would rise to static heads if depletions of storage were due only to flow from the catchments at the gauging stations. Jonkershoek streams approach this head at night during the period of almost level flow. During this time storage must become very nearly fully replenished. Troxell did not observe such periods of nearly level flow in streams, but he did stress that a static head must exist for the ground-water table. The streams in the Santa Ana Valley are all falling streams which decrease in flow, because they enter a dry region. Additions to storage are, therefore, derived mainly from stream-bed absorption. It may be accepted that the Jonkershoek streams are rising streams, although no recordings at double stations are at present available. Additions to storage from ground-water seepage out of the higher parts of the catchments must, therefore, be considerable. In these catchments the replenishment of ground-water should be more rapid. This may account for the fact that a static head is approached so much sooner than in Santa Ana streams.

The main differences between Troxell's interpretation of the form of fluctuations, and that which has been set forth here may be summarised as follows: (a) the effect of evapo-transpiration losses on streamflow at gauging point is delayed; (b) the steepness of fall or rise does not indicate the magnitude of differences, but the rate of change in differences between additions and extractions from storage; (c) the magnitude of differences is indicated by total extent of fall below the static head of flow for each day, which represents a point on the normal depletion curve.

If the water supplied to a catchment as precipitation is included in the definition of additions to storage, the following extended hypothesis may be formulated: the trend of streamflow at all times depends on the difference between additions of water to and extractions from storage; the rate of rise or fall depends on the rate of change in the differences between additions to and extractions from storage; and, when these are equal, the streamflow will be in equilibrium and, therefore, remain level. If this hypothesis proves to be sound, it may be possible that the behaviour of a depression in streamflow is similar to that of a spate. It may then also prove significant that the form of diurnal fluctuations in Jonkershoek streams during dry weather resembles the form shown by the mirror image of an inverted spate, if such a spate is derived from a single uniform rain affecting the whole catchment.

Fluctuations as Relative Measures of Consumptive Use of Water Along Streams

Differences in the interpretation of the form of diurnal fluctuations do not affect the general conclusions that they are caused by evapotranspiration losses and that transpiration probably exercises a stronger influence than evaporation. It appears to be justified, therefore, to base indirect relative estimates of the consumptive use of water along stream courses on the daily water losses indicated by the fluctuations.

If the periods of relatively level flow recorded in Jonkershoek are connected by a straight line, the area enclosed by the fluctuation curve and the interpolated line will give such an indirect relative estimate of the volume of water lost to the stream on that particular day. At Jonkershoek these estimates are being calculated for all streams on all days on which fluctuations occur.

Troxell has shown that the actual volume of water lost will be higher than an estimate made in this way (Troxell, '36). In these investigations where we are mainly concerned with comparisons between various treatments of catchments, the actual losses are not required, however. It would, in any case, be practically impossible to determine the exact area over which the losses have occurred, because at Jonkershoek the hillside vegetation merges gradually into the stream bank vegetation, without any marked line of transition. It must, therefore, remain uncertain for the present to what distance away from the stream the plants are still able to influence the daily fall and rise.

TABLE II.

Relative estimates of annual water losses based on diurnal fluctuations in streams

Stream and Year	Total Annual Yield of Stream in 1,000 gallon units	Total Annual Water Losses in 1,000 gallon units	Percentage Loss
Bosboukloof:			
1938	201,049	5,292	2.63
1939	133,019	5,623	4.23
1940	154,577	5,284	3.42
Biesievlei:			
1940	34,956	1,250	3.58
Tierkloof:			
1940	310,314	2,551	0.82

In Table II the estimates of total annual water losses for three streams are given. The data is as yet too meagre to arrive at definite conclusions, but the figures for Bosboukloof appear to indicate that the total loss for this stream is relatively constant despite considerable differences in the total annual yield of the stream from year to year. A significant change in the losses from a particular catchment after change of management would, therefore, probably be an indication of the effect of the new treatment. The percentage losses show that the fluctuations affect only a relatively small portion of the flow. Figures for the year 1940 show that the relative loss is highest in *Biesievlei,* less in *Bosboukloof* and lowest in *Tierkloof*. This relationship has also been indicated by the relative fluctuation curves reproduced in Fig. 3.

The extent of the diurnal fluctuations, because they are caused by evaporation and transpiration, should be correlated with weather factors controlling these processes. The relationship between fluctuations and atmospheric humidity and temperature has been illustrated in Fig. 2. An even closer correlation should be obtained with measures of atmospheric evaporation capacity, as given by Livingston-Thone atmometers, for example; or, with relative measures of transpiration as obtained from phytometers. It is hoped to provide such observations in future. At present the best available indication of the conditions promoting evapotranspiration is the warmth of the weather as shown by the daily maximum temperature. Regressions of daily water losses on daily maximum temperature have, therefore, been calculated (Fisher, '36, p. 134). In Fig. 5 the mean daily water losses for each degree class of temperature

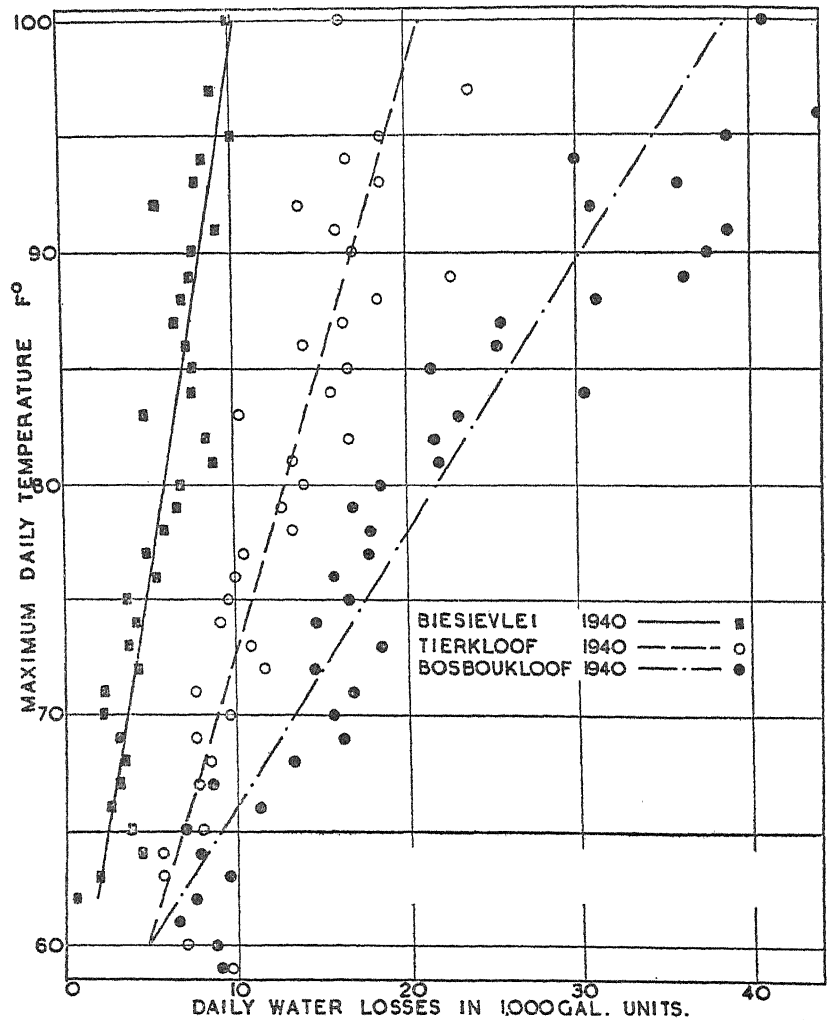


Fig. 5.—Regressions of daily water losses on maximum daily temperature.

have been plotted for three streams for the year 1940. The calculated regression lines for the streams have also been shown. The points show a fairly wide scatter, because maximum temperature is a poor indication of the weather conditions favouring evapo-transpiration and because the individual daily estimates of water lost as taken from streamflow charts are relatively inaccurate. Fig. 5 does indicate, however, that the three streams show distinct regressions.

It is possible that the regressions might be slightly curved. For annual estimations the fit will probably not be greatly improved by introducing curvilinear functions, however, because of the high residual variance due to chance as indicated by the wide scatter of observations on both sides of the regression lines (Fisher, '36). Because the exact trends of the regressions are not known, the linear regression functions may not be used for inter- or extrapolation. They may, however, be used to compare the general relationship between daily maximum temperature and water losses from year to year, before and after treatment, and from one catchment to another. If the standard errors of estimation are too great to show small differences due to treatment, it may be necessary to combine the readings of several years and fit—possibly more sound—curvilinear regressions. The characteristic differences shown by the linear regressions given in Table III and those depicted in Fig. 5 indicate that these will probably be sufficiently accurate estimates for the purpose of this investigation.

TABLE III.

LINEAR REGRESSIONS OF DAILY WATER LOSSES (Y) ON MAXIMUM DAILY TEMPERATURES (X)

Stream and period of observations	Regression function: $Y = a + b(x - \bar{x})$
Biesievlei:	
1940	$Y = 5.46 + .223\ (x - 78.02)$
Tierkloof:	
1940	$Y = 12.56 + .413\ (x - 78.75)$
Bosboukloof:	
1940	$Y = 18.46 + .850\ (x - 76.12)$
1939	$Y = 20.31 + .930\ (x - 77.29)$
1938	$Y = 24.35 + .721\ (x - 77.88)$
1938-1940	$Y = 20.84 + .818\ (x - 77.03)$
Summers:	
1938-1940 (Jan., Feb., Nov., Dec.)	$Y = 26.05 + .795\ (x - 81.24)$
Winters:	
1938-1940 (May, June, July, Aug.)	$Y = 9.46 + .154\ (x - 71.59)$

The regression coefficients—values of *b* in the functions in Table III—show that for a rise of one degree in maximum daily temperature the increase in loss of water from the stream is much greater in *Bosboukloof* than in *Tierkloof* and *Biesievlei*. There is also a marked difference in the summer and winter regression functions for *Bosboukloof*, 1938-1940. Not only is the mean daily volume of water lost—values of *a*—in winter much lower, but the increase in loss associated with a rise in temperature—indicated by values of *b*—is much less in winter. The regressions also differ from year to year in the same catchments even without change in treatment, but these differences are relatively slight compared to those which exist between catchments, and the very marked difference found between summer and winter regressions. It remains to be seen what

effect changes in the management of catchments will have. The significance of such differences in regressions may be statistically tested in the usual way (Fisher, '36, p. 146). The object of this discussion is merely to show that such comparisons should be of value in determining the influence of various treatments on the consumptive use of water along stream courses. At Jonkershoek they should show, for conditions where an adequate supply of ground-water is available, whether natural indigenous plant communities use more or less water than plantations of exotic pine trees.

Summary

Records of streamflow from the Jonkershoek Forest Influences Research Station show diurnal fluctuations during warm rainless weather, which must be due to evaporation and transpiration losses of water from the streams and their banks. The fluctuations are described, discussed and compared with those observed in streams and wells in the Santa Ana River Valley, California, U.S.A. The form of fluctuations is interpreted on the basis of a hypothesis, according to which the fluctuation curve reflects the rate of change of differences between additions to and extractions from water storage; and the effect of a change in such differences is delayed at the point of gauging.

It is claimed that an indirect relative measure of evapo-transpiration losses along stream courses may be based on the fluctuations. The relationship of daily water losses from streams to an independent measure of weather conditions promoting evaporation and transpiration would be a suitable indication of the effects of management of catchment on consumptive use of water along streams. At Jonkerhoek the only such measure of weather conditions generally available at present is the maximum daily temperature. The suitability of linear regressions of daily water losses on maximum daily temperature as criteria for comparing various catchment treatments is, therefore, discussed.

References

Blaney, H. F., Taylor, C. A. and Young, A. A.: Rainfall Penetration and Consumptive Use of Water in the Santa Ana River Valley and Coastal Plain. California State Bull. No. 33. Publ. by Div. of Water Resources, California. 1930.

Blaney, H. F. and Troxell, H. C : Water Losses under Natural Conditions from Wet Areas in Southern California. California State Bull. No. 44. Publ. by Div. of Water Resources, California. 1934.

Engler, A.: Untersuchungen über den Einfluss des Waldes auf den Stand der Gewässer. Mitt. d. Schweiz. Zentralanstalt f.d. forstl. Versuchswesen. Bd. 12. Zürich. 1919.

Fischer, R. A.: Statistical Methods for Research Workers. 6th ed. Oliver & Boyd, London. 1936.

Horton, R. E.: Surface Run-off Phenomena. Part I—Analysis of the Hydrograph. Publ. No. 101. Horton Hydrological Laboratory. Voorheesville, New York. 1935.

Hoyt, W. G. and Troxell, H. C.: Forests and Streamflow. Am. Soc. of C.E., Trans. 99:1. 1934.

Taylor, C. A.: Transpiration— and Evaporation—Losses from Areas of Native Vegetation. Trans. of American Geophys. Union 15th Annual Meeting. Publ. by National Research Council, Wash., D.C. 1934.

TROXELL, H. C.: The Diurnal Fluctuations in the Ground-water and Flow of the Santa Ana River and its Meaning. Trans. of American Geophys. Union 17th Annual Meeting. Publ. by National Research Council., Wash., D.C. 1936.

WICHT, C. L.: Forest Influences Research Technique at Jonkershoek. Journal of the S.A. For. Assoc. 3:65-80. 1939.

————: A Preliminary Account of Rainfall in Jonkershoek. Trans. of the Royal Soc. S.A., 28:161-173. 1940.

Transactions of the American Geophys. Union, 1935 and 1936. Reports and Papers. Sect. of Hydrology. Publ. by National Research Council.

EUCALYPTUS SALIGNA AND SOIL RECLAMATION

By H. A. READ

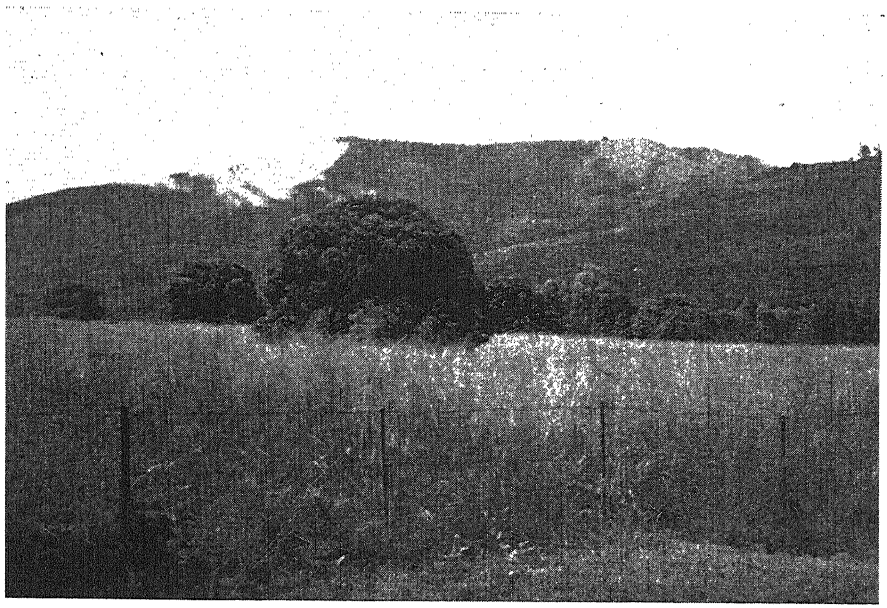
THE Panzer Divisions of mechanized agriculture have for years past charged over the face of Mother Earth. Mechanical improvements have accelerated the pace in recent years, but the wreckage caused is seen in abandoned farms and eroded areas in many lands. Gone is the valuable humus so essential for crop production. Storms channel the surface and each year the gashes of erosion grow deeper. Millions of tons of valuable soil are discharged every year into the ocean or carried into conservation systems to block them up. Gone, too, are the trees and forests destroyed by axe and fire. The "dust bowl" of Western America has been thus produced. There is no need to elaborate the picture. Much has been written on the necessity for restoration of fertility, on soil conservation and on the checking of erosion. The problem is world-wide, although it varies from land to land and from district to district.

The following is a brief account of recent observations in the Northern Transvaal where in certain areas an important measure of success in soil reclamation has been obtained by tree planting.

The area is one of relatively high rainfall, lying on the edge of the low veld at the foot of the slopes of the Woodbush between Duivelskloof and Tzaneen. The soil is deep and the district enjoys a mild and frost-free climate. In this area some 35 years ago steam ploughing was practised by those who first occupied the land, which at that time was virgin soil. But in the process of cultivating the land for crops of mealies and ground nuts little thought was taken of the future. Contour ploughing was not practised and the plough was driven up hill and down dale. The result was that in a few short years over large areas the humus had vanished, having been washed away by heavy rains and nothing was left but burnt-out red soil incapable of producing any crops and on which nothing but the lowest types of creeping vegetation could live. Erosion set in and dongas could be seen everywhere. Termites occupied the ground to such an extent that hundreds of nests per morgen had to be taken out when new reclamation started.

On a portion of this area before it was totally wrecked, plantations of *Eucalyptus Saligna* were established some 20 years ago. Despite the fact that the land had been badly handled and a considerable amount of the humus lost, the trees in due course established themselves and yielded two or three crops of mining laggings.

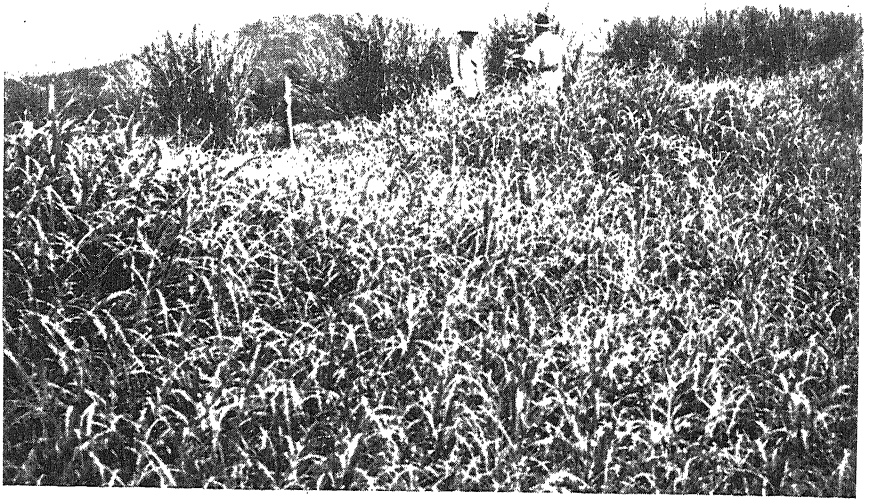
Some 10 years ago the estate passed into the hands of Dr. Hans Merensky, who early recognised the vital importance of reconditioning eroded and worked-out areas. The areas on which no trees had been established were extensive. Much of the ground was in a condition infinitely worse than the worst type of kaffir lands. At first, attempts were made to prevent further erosion and to restore condition to the surface by contour planting of vigorous grasses, such as Napier fodder. This, however, was not successful. But observations led to the examination of some of the areas which in years previously had been planted with



Buffels grass *(Panicum maximum* Jacq.*)* in seed on clear-felled saligna area.



Haymaking on same area as above.



Star grass *(Cynodon plectostachyum* Pilg.*)* on clear-felled saligna area.



Napier fodder *(Pennisetum purpureum* Schum*)* on clear-felled saligna area.

E. Saligna, which was then strongly established. It was seen that the condition of the soil had been greatly improved and Dr. Merensky, therefore, decided to set out other plantations on ground so poor that no agricultural crops could possibly have succeeded. In a few years the trees had a strong hold and demonstrated that even under the most unpromising conditions the decomposition of leaves, twigs and bark could rapidly produce a blanket of valuable humus.

Last year Dr. Merensky decided to test on a fairly large scale the value for agricultural purposes of one of these areas in extent about 30 morgen, which had been planted with *E. saligna* about 20 years ago, the land having been rendered unfit for the production of mealies or ground nuts. By 1940 the plantations had been felled three times for mining laggings. The area was stumped and examined. It was found that the decomposition of leaves, branches and bark shed, including that accruing in large quantities when the trees were cut and including also the crowns of the trees at times of felling, had during a period of approximately 20 years restored to the surface a blanket of dark humus about 10 inches in depth. The subsoil was loose and in fine condition for cultivation owing to the action of the root system of the trees which had broken up the soil to an appreciable depth. An analysis of the ash from the saligna bark was then made and showed the following results :—

Lime (CaO)	25·50%
Potash (K_2O)	4·65%
Phosphoric Oxide (P_2O_5)	0·32%

Another analysis of bark ash gave a lime content of 52%. Observations on a neighbouring estate (Rooikoppies) confirmed the remarkable addition of humus made to the soil by this tree. On an area originally occupied by rough grasses and low growing trees, but which less than 30 years ago was planted with *E. saligna*, the soil had in that time acquired a blanket of more than 6 inches of humus.

Check analysis of ash from bark collected at Rooikoppies Estate gave the following results :—

Lime (CaO)	New bark	31·3%
	Old bark	28·5%
Potash (K_2O)	New bark	8·5%
	Old bark	6·0%
Phosphoric Oxide (P_2O_5)	A trace only in each	

The yield of ash per ton of air dried bark was 33·6 and 51·5 pounds for new and old bark respectively.

The area of 30 morgen above referred to was then planted in paddocks with different grasses — Buffelsgrass, Napier Fodder and Star grass, recently introduced into the Union by Dr. Pole-Evans. The area was planted in December, 1940. So vigorous was the growth of all the grasses that some were cut in the middle of February for haymaking. It was expected that a second crop would be secured from the area at the end of the rainy season. Grasses were cut before seeding at a height of about 3 feet. In the uncut Buffelsgrass paddock the grass in seed reached a height of 8 feet. Reference to the photographs accompanying this article shows the phenomenal growth of all the grasses.

Some remarks on the habits of *E. saligna* are appropriate. This variety seems first to have been introduced into the Duivelskloof area about 35 years ago. The tree very soon became noticeable owing to its vigorous growth. Trees planted 9′ x 9′ in one year make canopy to such an extent that the whole surface is shaded. This is a very important factor as it promotes the bacterial destruction of the debris. From about the third year the tree begins to send down an increasing shower of branches, leaves and bark. This debris helps to shade the soil still more effectively. The forest floor of a plantation even 7 or 8 years old is littered to a depth of several inches with trash, which under the action of bacteria rapidly breaks down. Decomposition to humus is very rapid in comparison with the decomposition of say pine needles. The cell structure and mineral content of saligna litter seems to be ideal for the making of compost. Harsh red soil, incapable of producing anything, in a few years changes colour to a wholesome chocolate and there is a rapid improvement in its mechanical condition. An article entitled "An Alien in Brazil," by Dr. Edmundo Navarro de Andrade, appeared in "American Forests" of July last. This deals with the developments in Brazil on a very large scale of eucalypts, amongst which *E. saligna* is mentioned. The writer observes "that the *eucalyptus* enriches the soil with the falling of leaves, little branches and fruits with an average weight of 12,500 lbs. an acre a year." The species of eucalypt on which this observation is based is not stated. It seems possible that litter in a plantation of *E. saligna* might produce this result and even larger accumulations of litter if the plantations are felled at short intervals. It is also assumed that Signor Andrade's figures include the weight of bark, the shedding of which at regular intervals is an outstanding feature of *E. saligna*.

Other eucalypts grown in the Union do not enrich the soil to the same extent. Plantations of *E. paniculata, E. maculata, E. pilularis, E. resinifera* and other eucalypts deposit very little litter on the forest floor and the addition of humus to the soil is correspondingly small.

There are also indications that the root system of *E. saligna* is helpful in checking erosion in its early stages by holding up leaves, branches, soil, etc., and by exercising a binding effect on the soil, but further investigation on this point is desirable.

The results thus far obtained point to the need for further observation and investigation. In areas of lower rainfall and temperature the results would not be so favourable. But it is necessary to issue a note of warning and to say that the Duivelskloof results can hardly be expected elsewhere except under similar conditions. They are, however, so remarkable that further enquiry in other parts of the Union and, in fact, in other parts of the world should be undertaken.

Much of the information in these notes has been kindly supplied by Dr. Hans Merensky.

KNIKFORMULES IN DIE ALGEMEEN MET SPESIALE VERWYSING NA 'N NUWE VERGELYKING

DEUR H. L. MALHERBE

(Asst. Benuttingsbeampte, Afdeling Bosbou.)

WANNEER 'n houtliggaam aan uitwendige kragte onderwerp word, word 'n spanning in sy vesels opgewek waarvan die uitwerking op die vorm van die liggaam deur die eienskappe van die betrokke vesel bepaal word, wat uiteindelik na die molekulêre hoedanigheid van die vesel terug te voer is.

Word druk uitgeoefen op die twee ente van 'n staaf, waarvan die veselrigting met die lengte-as van die staaf saamval, dan is daar 'n samedrukking van die staaf in die veselrigting en ontstaan in die staaf 'n drukspanning. Die weerstand wat die staaf deur uitgeoefende kragte bied, is die weerstand teen druk en word uitgedruk per oppervlakte-eenheid. Hierdie syfer toon die *vastheid teen druk* parallel met die veselrigting aan, wat sy maksimum *(V)* bereik net voordat breuk intree. Die mate van weerstand wat hier teen vormverandering gebied word, word deur die *elastisiteitsmodulus by druk (E)* aangedui, 'n grootheid wat eksperimenteel bepaal word by die proporsionaliteitsgrens, d.w.s. die grens van dié gebied waar die vormveranderinge in die liggaam eweredig is met die kragte waaraan dit onderwerp word. Die spanning in die staaf by hierdie grens staan dan ook bekend as die *spanning by die proporsionaliteitsgrens* (σ_p).

Wanneer 'n staaf as kolom of pilaar (enige drukstaaf) gebruik word, waarop die uitwendige kragte aan die twee ente in teengestelde rigting werk, kan die eksperimenteel-bepaalde waarde vir die vastheid teen druk nie onder alle omstandighede onveranderd as maatstaf dien vir die berekening van die minimum veilige dwarsafmetings van 'n staaf wat gegewe uitwendige kragte moet weerstaan nie.

Rede hiervoor is dat wanneer die verhouding tussen die lengte van 'n kolom en sy kleinste traagheidsstraal (in geval van 'n reghoekige deursnede $\frac{b}{\sqrt{12}}$ waar b die kleinste dwarsafmeting is) 'n sekere grens oorskry, dan is die staaf onderhewig aan uitbuiging of knik, en breuk sal gevolglik intree voordat daardie krag bereik word, wat die spanning tot sy normale maksimum *(V)* laat styg. Hierdie omstandigheid word in houtkolomme vererger deurdat daar weens aansienlike verskille in die vesel-opbou van die staaf en/of onvermydelike afwykinge in die sentriese uitoefening van die druk niebepaalbare spannings in die staaf opgewek word wat sal bydra om die staaf eerder te laat buig en breek.

Dit is dus wenslik om daardie onsekerhede in 'n formule in berekening te bring waaruit af te lei is :—

1. Die spanning waarby 'n staaf met 'n gegewe slankheid sal knik;

2. Die maksimum slankheid wat, by 'n gegewe spanning in 'n staaf, toegelaat mag word.

So 'n formule is dié van *Euler,* waarvan die algemene vorm as volg is :—

$$\sigma_k = \frac{\pi^2 E}{\lambda^2} \text{ of } P = \frac{\pi^2 EI}{l^2}$$

waarin

σ_k = spanning waarby knik sal intree.
E = elastisiteitsmodulus by druk.
λ = slankheidskoëfisiënt.
l = effektiewe staaflengte (ook kniklengte).
i = traagheidsstraal.
P = krag uitgeoefen.
I = traagheidsmoment.

Uit die eerste vorm van hierdie vergelyking blyk dat die knikspanning in omgekeerde verhouding staan tot die kwadraat van die slankheid, m.a.w. die spanning waarby knik sal intree neem vinnig af met toename in die slankheid.

In grafiek oorgebring neem die formule van Euler die vorm aan soos in Figuur 1 aangetoon word.

By die opstelling van sy formule het Euler egter van sekere ideale omstandighede uitgegaan; o.a. het hy veronderstel dat breuk slegs as gevolg van knik sal intree en nie as gevolg van die meganiese verbryseling van die vesels deur die drukking nie. Die vastheid teen druk word derhalwe glad nie in sy formule in aanmerking geneem nie. Verder het hy aangeneem dat die druk matematies volkome in die lengte-as van die staaf toegepas word, en dat die materiaal volkome homogeen is.

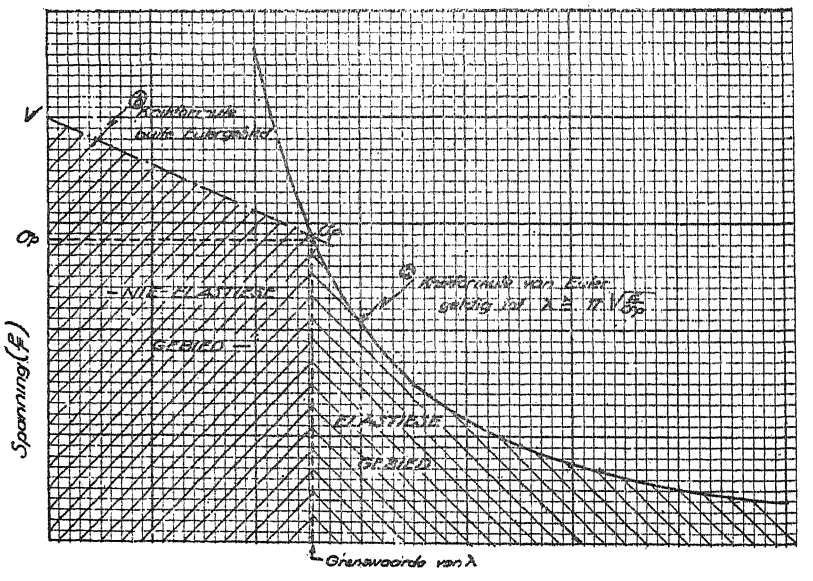


FIG. 1.—Vorm van Euler se formule.

Die uitwerking van die eerste van hierdie oorwegings in die praktyk is dat die formule slegs tot 'n sekere grens van toepassing is want, soos uit die figuur blyk, indien die formule onvoorwaardelik vir alle omstandighede aangeneem word, sal die knikvastheid toeneem tot 'n maksimum wat oneindig hoër lê as die vastheid teen druk, wat natuurlik onsinnig is. Hoewel die formule van Euler dus oor die algemeen die beste uitdrukking gee aan die verloop van die knikspanning binne 'n sekere gebied, sal daar vervolgens verdere formules nagegaan word, wat die verhouding van spanning/slankheid buite daardie gebied behartig.

Oor die vorm van die lyn wat die knikformule buite die gebied van Euler grafies moet voorstel is reeds heelwat gespekuleer soos uit Figuur 2 blyk.

Dit is nodig om die begin- en eindpunte van hierdie lyn vas te stel, m.a.w. daar moet besluit word op grenswaardes van slankheid (en spanning) waartussen hierdie formule geldig sal wees. Met die slankheid as uitgangspunt kan die *minimum waarde van die slankheid,* $\lambda = 3{\cdot}5$ geneem word want hier is die lengte gelyk aan die kleinste dwarsafmeting ('n kubus byvoorbeeld) en word $\sigma_k = V$. Newlin en Gahagan (2) gaan selfs so ver as om kragtens die resultate van talryke proewe aan te neem dat vir alle praktiese doeleindes houtkolomme met 'n slankheidsverhouding $\lambda = 38$ nog op die volle waarde van V bereken mag word.

Die maksimum waarde van λ, by die oorskrying waarvan die Euler-formule gebruik moet word, verskil by verskillende outeurs tot 'n byna ongelooflike mate, soos in die volgende twee gevalle aangetoon word, en nog vollediger in Figuur 2 voorgestel word.

In die knikformule van *die V.S.A. Bosprodukte Laboratorium*:

$$\sigma_k = V\left[1 - \tfrac{1}{3}\left(\frac{\lambda}{\beta_1}\right)^4\right]$$

is die koëffisiënt β_1, 'n konstante van slankheid wat bepaal word uit die formule van Euler by 'n spanning gelyk aan $\frac{2}{3}\ V$ as maksimum. Dit is dus duidelik dat wanneer $\sigma_k = \frac{2}{3}\ V$ dan word in bostaande vergelyking $\lambda = \beta_1$, en hieruit volg dat λ by daardie waarde sy maksimum bereik en dus as grenswaarde beskou moet word.

Deur C. C. Forsaith (1) word die volgende formule aangehaal wat deur *Boyd* uit die formule van Euler afgelei is:—

$$\sigma_k = V - \lambda\left(\frac{2V}{3\pi}\sqrt{\frac{V}{3E}}\right)$$

Hierdie formule is terloops identies met dié wat bekend staan by die formule van T. H. Johnson.

In 'n grafiek oorgebring gee bostaande formule 'n reguit lyn wat as tangens die kurwe van Euler raak by $\sigma_k = \frac{1}{3}\ V$. Die waarde van λ by hierdie punt vorm hier weer die maksimum waarde, verby welke punt die formule van Euler geldig word.

Uit die aangehaalde gevalle blyk dus tot watter mate die grense arbitrêr vasgestel of aangeneem word—in die een geval die waarde van λ by $\sigma_k = \frac{2}{3}\ V$, in die ander by $\sigma_k = \frac{1}{3}\ V$. Op dieselfde manier kan verskeie ander formules behandel word (Rankine, J. B. Johnson en andere) en op een uitsondering na (v. Mechelen) blyk ten slotte dat betreklik willekeurige grense die waarde van λ by die werklike eksperi-

menteel-bepaalde spanning by proporsionaliteitsgrens (σ_p) vervang. Met die oog daarop is dit wenslik om nadruk te lê op die feit dat die formule van Euler van toepassing word vanaf daardie oomblik dat 'n spanning in die staaf opgewek word wat gelykstaan aan die spanning by die proporsionaliteitsgrens. Die juiste waarde van λ wat die grens tussen die gebied van Euler en daarbuite aandui is dus ook die waarde wat die grens tussen die elastiese en die nie-elasties gebied daarstel, d.i. waar:—

$$\lambda = \pi\sqrt{\frac{E}{\sigma_p}}$$

waarin σ_p die eksperimenteel-bepaalde spanningswaarde is.

Noudat die grense van die nie-elastiese gebied aangeneem kan word as:—

$$\lambda = 3{\cdot}5 \text{ as minimum}$$

en

$$\lambda = \pi\sqrt{\frac{E}{\sigma_p}} \text{ as maksimum,}$$

moet die verloop van die lyn wat die grafiese voorstelling van een of ander formule is, nagegaan word.

Ook hier word die uiteenlopendste menings gehuldig, daar beide die reguit lyn sowel as 'n verskeidenheid van kurwes aangetref word. Ten opsigte van die Euler-kurwe bied die verloop van so 'n lyn vier moontlikhede, waarvan voorbeelde in Figuur 2 grafies voorgestel word:—

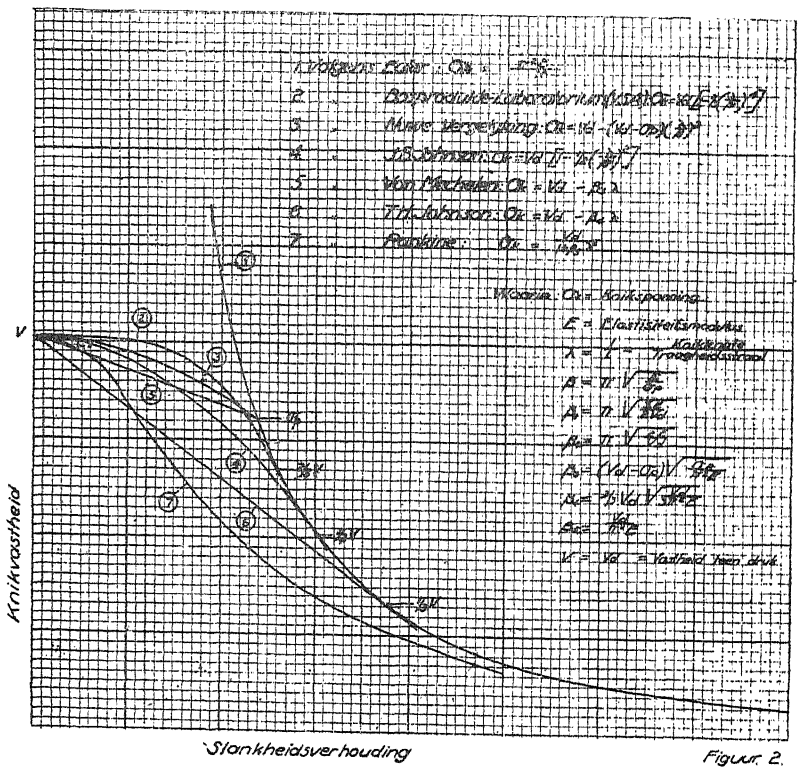


FIG. 2.—Vorme van verskillende formules.

1. 'n Kromme tangens aan die kurwe van Euler (V.S.A. Bosprodukte Laboratorium 8ste mag, en hersiende 4de mag formules, J. B. Johnson 2de mag).
2. Kromme wat die Euler-kurwe sny.
3. Reguit lyn, tangens aan die kurwe van Euler (Assam, T. H. Johnson.
4. Reguit lyn wat die Euler-kurwe sny (Tetmajer, van Mechelen).

Hoewel die teendeel nog nie bewys is nie, is daar ook geen rede om aan te neem dat die lyn van die nie-elastiese gebied 'n raaklyn aan die Euler-kurwe moet wees nie. In hierdie verband is die volgende aanhaling uit die werk van Van Mechelen (5) interessant en van belang: „ . . . . aan de formule van Euler ligt de wet aan Hooke ten grondslag, en het is te begrijpen, dat bij overschrijding van die proportionaliteitsgrens een *plotselinge* richtingsverandering zal optreden in die lijn die het verband tusschen de slankheid en de knikvastheid aangeeft." Die plotselinge rigtingsverandering kan alleen tot uitdrukking kom wanneer ten opsigte van die Euler-kurwe die lyn van die nie-elastiese gebied 'n snylyn en nie 'n raaklyn is nie.

Word daar op grond hiervan aangeneem dat 'n snylyn die beste uitdrukking gee aan die spanningsverandering by die oorgang van die elastiese na die nie-elastiese gebied, dan is daar nog die keuse tussen 'n reguit lyn en 'n kromme. Beide uit teoretiese oorwegings en praktiese waarnemings soos te boek gestel deur Newlin en Gahafan (2) en andere, kan daar min twyfel bestaan dat 'n kromme die juiste weergawe van die verloop van die spanning by gegewe slankhede is, hoewel daar uit 'n praktiese oogpunt, ook met die oog op groter veiligheid sekere voordele in 'n reguit lyn is.

Daar word dus aangeneem dat die lyn 'n kromme moet wees wat die Euler-kurwe sny en dat dit moet strek tussen die reeds vasgestelde grense. (Dit dien net gemeld te word dat die lyn onder omstandighede 'n raaklyn mag word, maar dit sal uitsonderlike gevalle wees en bloot toevallig.)

Met hierdie beskouings in gedagte word die volgende algemene formule voorgelê in 'n poging om die gesamentlike uitwerking van verskillende teoretiese oorwegings uit te druk, die praktiese geldigheid waarvan nog eksperimentele bekragtiging vereis.

$$\sigma_k = V - (V - \sigma_p) \left(\frac{\lambda}{\beta}\right)^2$$

waarin β = koëffisiënt van slankheid wat vid iedere houtsoort bepaal moet word uit:—

$$\beta = \frac{l}{i} = \pi \sqrt{\frac{E}{\sigma_p}}$$

(Opgemerk moet word dat gemakshalwe $\lambda = 0$ as onderste grens aan geneem word, terwyl in werklikheid σ_k reeds gelyk word aan V by $\lambda = 3{\cdot}5$. By die toepassing in die praktyk sal dit egter weinig saak maak, aangesien dit die berekende waarde van σ_k iets laer maak en dus die veiligheid ten goede beïnvloed.)

Die verloop van die lyn vir *Pinus insignis* word in Figuur 3 aangedui, volgens syfers goedgunstiglik verskaf deur Bosprodukteinrigting, Pretoria.

Die uitwerking van gebreke (kwaste, ens.) in 'n staaf, van die vogtigheidsgehalte daarvan en van die omstandighede waaronder dit gebruik word, op die sterkte as kolom, vorm interessante onderwerpe vir verdere ondersoek en sal waarskynlik die formule, of in ieder geval die waarde van β, aansienlik beïnvloed.

Verder bestaan daar die moontlikheid dat soortgelyk aan die prosedure gevolg deur Van Mechelen vir Indiese houtsoorte, soorte in Suid-Afrika gekweek, groepeer kan word, en met een besondere formule vir elke groep met enkele empiriese gegewens daarin volstaan kan word. Vir 'n dergelyke ondersoek ontbreek daar egter vandag nog te veel gegewens.

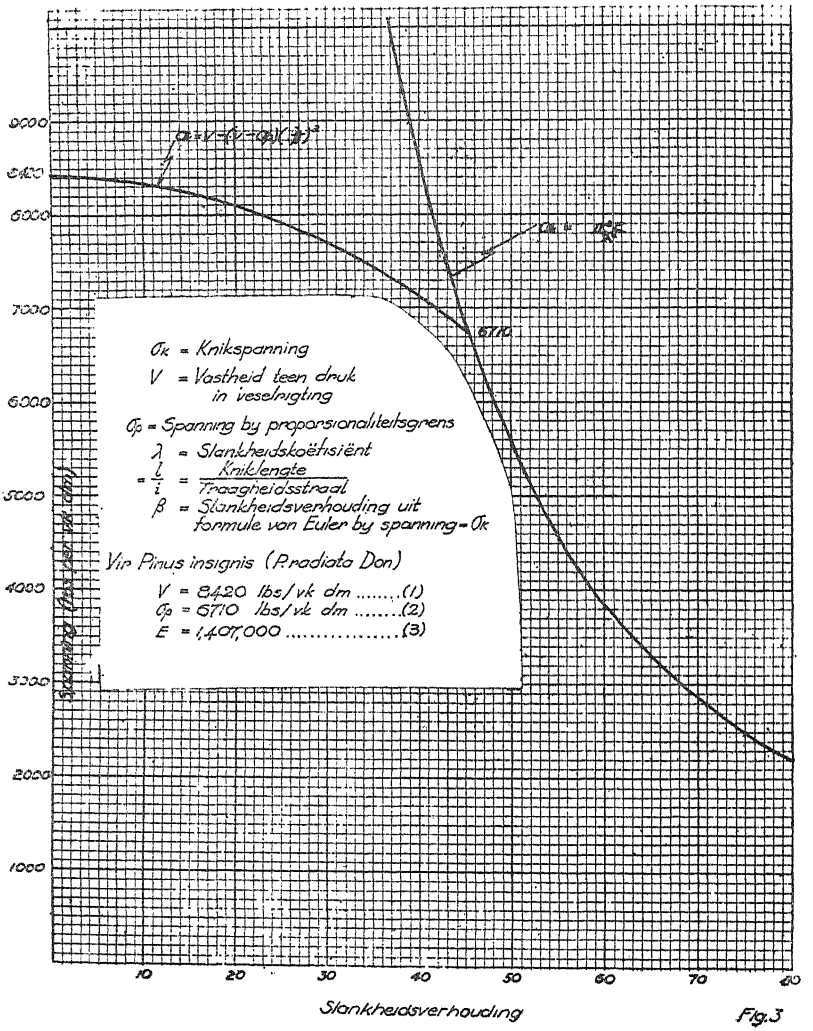


FIG. 3.—'n Nuwe vergelyking.

TOEPASSING VAN FORMULE: SYFERVOORBEELD

Die minimum dwarsafmetings van 'n vakwerkstaaf in 'n brugkonstruksie moet bereken word, waarby die volgende gegewens bekend is:

Lengte *(l)* van staaf tussen knooppunte = 5 voet.
Drukkrag *(P)* waarvoor voorsien moet word = 12 ton.
Sekerheidssyfer *(s)* = 7

Verder is vir die gegewe houtsoort (*P. insignis*):

Elastisiteitsmodulus by druk *(E)* = 1,407,000 lbs./vk. dm.
Vastheid teen druk parallel met veselrigting *(V)* = 8,420 lbs./vk. dm.
Spanning by proporsionaliteitsgrens σ_p = 6,710 lbs./vk. dm.

Die dwarssnede van die staaf is reghoekig, waarby $b = h$.

$$s\sigma_k = V - (V - \sigma_p)\left(\frac{\lambda}{\beta}\right)^2 \quad \ldots\ldots\ldots \text{(A)}$$

$$\sigma_k = \frac{P}{F} = \frac{P}{bh}$$

Stel $h = nb \qquad \therefore E = nb^2$

$$\therefore \sigma_k = \frac{P}{nb^2} \quad \ldots\ldots\ldots\ldots\ldots \text{(1)}$$

$$\lambda = \frac{l}{i} = \frac{l\sqrt{12}}{b}$$

$$\therefore \lambda^2 = \frac{12l^2}{b^2} \quad \ldots\ldots\ldots\ldots\ldots \text{(2)}$$

$$\beta = \pi\sqrt{\frac{E}{\sigma_p}} = 3{\cdot}1416\ \sqrt{\frac{1{,}407{,}000}{6{,}710}} = 45{\cdot}5$$

$$\therefore \beta^2 = 2{,}070 \quad \ldots\ldots\ldots\ldots\ldots \text{(3)}$$

Word (1) en (2) in A ingevoer, dan word

$$sP = nVb^2 = V - (V = \sigma_p)\ \frac{12\ l^2 n}{\beta^2}$$

Word die bekende waardes nou ingevoer:

$$7 \times 24{,}000 = 8{,}420\ b^2 - (8{,}420 - 6{,}710)\ \frac{12\ (60)^2}{2{,}070}$$

Hieruit $b^2 = 24{\cdot}2$
en $b = 4{\cdot}92$

Neem afgegrond $b = 5''$; *en* $h = nb = b = 5''$

Ten slotte moet gekontroleer word of die staaf wat so bereken is, nie miskien 'n slanke staaf is wat volgens die formule van Euler bereken moes gewees het nie.

Die eenvoudigste sal wees om hiervoor die grafiek te gebruik:

$$\sigma_k = \frac{sP}{F} = \frac{168{,}000}{25} = 6{,}720 \text{ lbs/vk. dm.}$$

By $\sigma_k = 6{,}720$, is $\lambda = 45{\cdot}4$.

Die grenswaarde van vir hierdie houtsoort is 45.5 sodat hierdie staaf nog net buite die Euler-gebied val en die berekening dus korrek

gedoen is volgens die formule vir die nie-elastiese gebied. Gebeur dit dat $\lambda > 45.5$ dan moet die afmetings bereken word uit die formule van Euler, as volg:

$$\sigma_k = \frac{\pi^2 E}{\lambda^2}$$

d.i. $$\frac{sP}{F} = \frac{\pi^2 E}{\frac{l^2}{i^2}} = \frac{\pi^2 E b^2}{12 l^2}$$

Stel $h = nb$

Dan is $F = nb^2$

Dus $$\frac{nb^2}{sP} = \frac{\pi^2 E b^2}{12 l^2}$$

Hieruit $$b^4 = \frac{12 sP l^2 n}{\pi^2 E}$$

$$\therefore\ b = \sqrt{\frac{l}{\pi}} \times \sqrt[4]{\frac{12 sPn}{E}}$$

en $h = nb$

LITTERATUUR

1. 1926. FORSAITH, C. C.: The Technology of New York State Timbers.
2. 1930. NEWLIN AND GAHAGAN: Tests of Large Timber Columns and Presentation of the Forest Products Laboratory Column Formula.
3. 1936. REYNOLDS AND KENT: Structural Steelwork.
4. 1937. TRAUTWINE: Civil Engineer's Handbook.
5. 1938. VAN MECHELEN, J. H.: „Berekening van Gedrukte Staven": De Ingenieur in Nederlandsch Indië, 5de Jaargang, Nos. 8, 9 en 10.
6. 1935. Wood Handbook: Forest Products Laboratory Publication.

THE PROPERTIES AND USES OF SOUTH AFRICAN KIAAT *(PTEROCARPUS ANGOLENSIS)* TIMBER

By M. H. SCOTT

(Senior Forest Products Officer.)

ALTHOUGH kiaat is a timber which has long been known as one of the most valuable of the Lowveld species, it is only comparatively recently that it has become available to the public in well-seasoned boards ready for manufacture into furniture. Its valuable properties and its particularly attractive appearance have now fully established it as the most popular indigenous timber of the Transvaal. The first known large-scale tests to be made on it were carried out by the Forest Department in conjunction with the Railway Administration. Under these auspices the dado boards and panelling for a number of main line coaches were manufactured from timber seasoned in the Forest Department's experimental kilns, the high satisfaction they gave resulting in further demands from the Administration, the use of the timber by whom may be seen with striking effect in the Johannesburg railway station. A little later it was included by the Public Works Department in specifications for furniture contracts, and has been used subsequently in some of the largest building contracts in preference to teak.

Owing to limited local supply, the increased popularity of the timber resulted in greater demand on sources of supply outside the Union, such as in Rhodesia and Portuguese East Africa, and there is now little difficulty in obtaining boards therefrom. For beauty of grain and figure, however, the local product remains unrivalled.

Common and Vernacular Names

Like many other timbers, kiaat has numerous alternative and regional names. In Rhodesia it is commonly known as mukwa, while in Portuguese territory its vernacular names, in addition to mukwa, are thondo and imbilo. In Tanganyika, muninga is the common name. Other local names are blackwood, sealing-wax tree, Transvaal teak, kejatenhout and kejaat. It is only in the last few years that the spelling "kiaat" has been recognised by local authorities as the standard name for the Union-grown timber. The similarity in sound between this and djati, the *Tectona grandis,* or true teak, of the Dutch East Indies, is easy to understand. Confusion may still arise, as "kiaat" is the Afrikaans for "teak."

Distribution Sizes and Value

The tree occurs fairly abundantly in parts of Rhodesia and in Portuguese East Africa, where, particularly in the latter, it attains a much greater size than in South Africa. It also occurs as far north as Tanganyika. In the Union the main source of supply has been the

Pilgrim's Rest District of the Transvaal Lowveld, but it occurs also in the foothills of the Drakensberg, in Swaziland, Northern Zululand and in Bechuanaland. While logs of 20 feet in length and 30 inches and more in diameter are obtainable from East Africa, local supplies seldom exceed 12 feet long and 2 feet in diameter, averaging about 7 feet and 13 inches respectively. The tree generally has a rather short crooked bole, which branches heavily, occasional branches themselves being of sawable size. During recent years a great deal of the larger timber, especially on private farms, has been exploited. There remain areas on Government-owned land, and most of the timber now being cut in the Union derives from native reserve.

Seedling growth is slow even under favourable conditions, seldom amounting to more than 2 feet a year in height. Only young trees are said to coppice well, when a height growth of three to six feet may be expected. Owing to sylvicultural difficulties, little is being done to assist in the re-establishment of the species beyond protection of the areas under Government control. The main source of supply will always be beyond the borders of the Union.

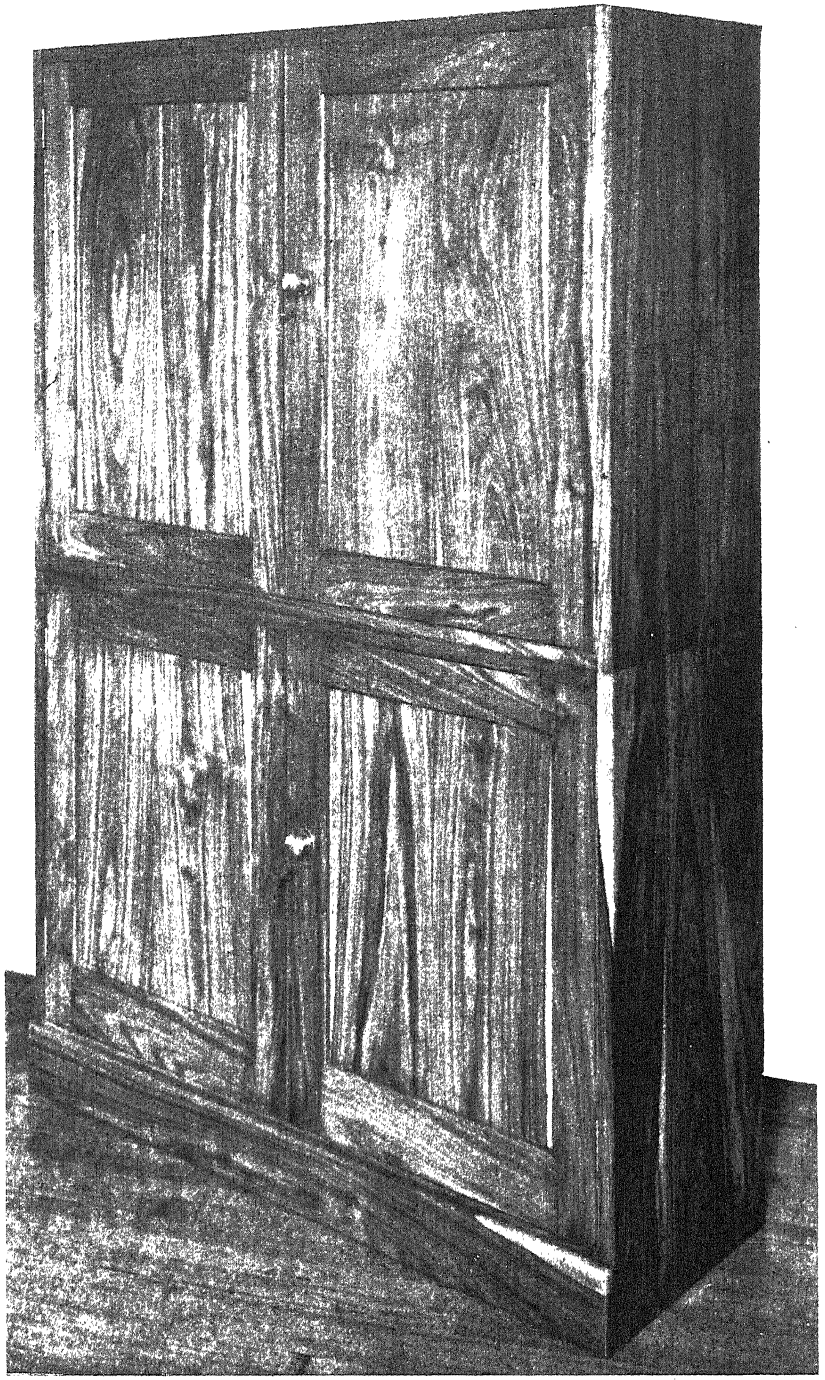
The value of logs varies considerably with size and quality, but prices which have been paid range from 50s. to 70s. per ton for round logs delivered at sawmill, and 200s. for selected squared baulks of good length free of sapwood. Well seasoned boards are worth from 12s. to 16s. and more per cubic foot.

Conversion and Yields

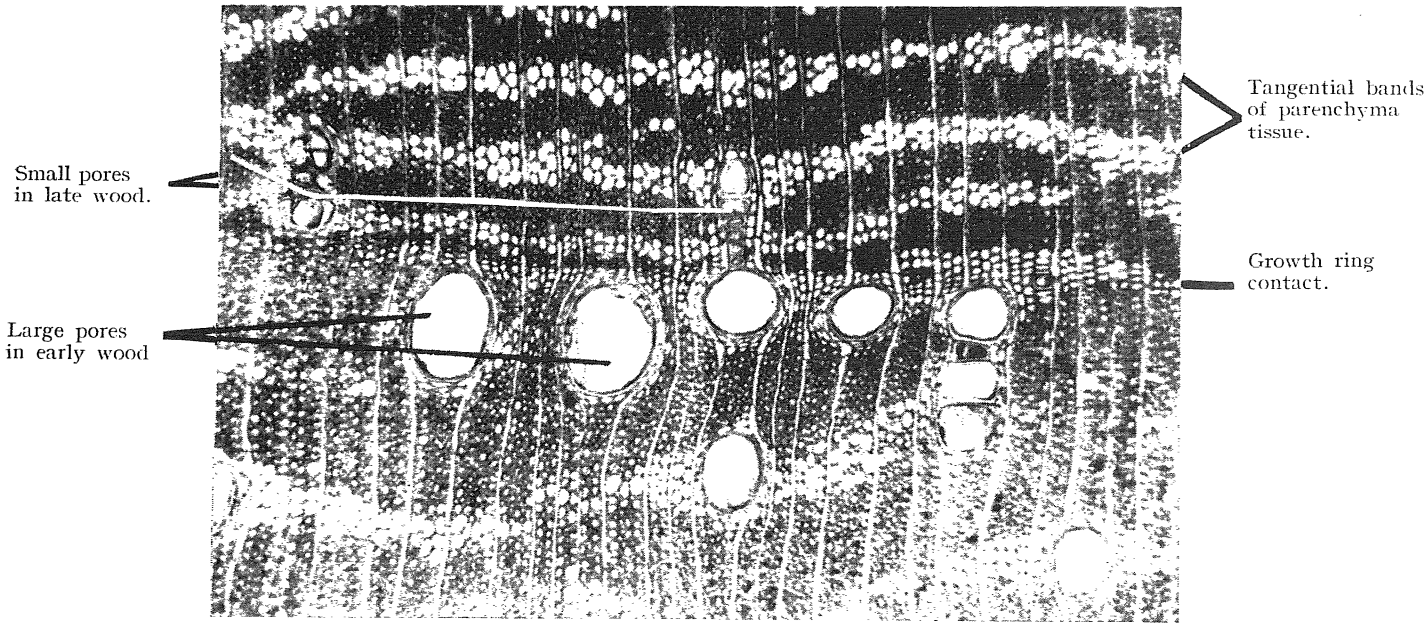
Transport difficulties and the prevalence of fever during the rainy summers of the Lowveld confine the exploitation of kiaat almost exclusively to the winter months. This is really an advantage, because the borers which attack the sapwood are then dormant, and logs may be left to lie for several months with little likelihood of damage. Round logs of kiaat will stand a considerable amount of exposure to the elements without deterioration. They are not prone to split and cases are known of logs having lain on the ground until the sapwood has rotted away, leaving the heartwood completely sound. There is, however, no advantage in keeping the timber in the round, and early conversion to boards is always recommended.

The percentage of white sapwood, more especially in small logs, is fairly high. It may vary from ¾ to 4 inches in width, but is usually about 1½, representing a volume of about 30 per cent. in a 15-inch log. All boards containing white sapwood may be dipped after sawing in zinc chloride or other preservative solution to discourage attack by borers during drying. A surer method of preventing attack, however, is to air dry them to a moisture content of about 20 per cent., following this up by full treatment in zinc chloride. They should then be finally redried either in the air or in the kiln to 10 or 12 per cent. In this way all danger of future attack in the sapwood is avoided. Retention of the sapwood increases the yield of serviceable timber by about 25 per cent., and is to be encouraged as, when properly matched, its inclusion in furniture, panelling, etc., is not at all unattractive.

A round volume of 100 cubic feet of average South African-grown kiaat saw logs will yield about 55 cubic feet of green squared boards. The balance of 45 cubic feet is lost in crooks, slabs and sawdust. The



Herbarium cupboard shewing lively grain contrasts of kiaat. The paleness of the sapwood strips in the lower half and the dowell, top right, is emphasized by the camera.



Kiaat *(Pterocarpus angolensis)*. Transverse section × 60.

allowance for seasoning and other defects is not more than 12 per cent. of the round log, while the volumetric shrinkage can be taken at 2 per cent. This leaves 41 per cent. of sound seasoned boards if the sapwood is retained. If heartwood only is to be utilised, a recovery of 30 per cent. is all that may be expected.

SEASONING

In Pretoria, boards up to one inch thick, stacked with one inch stickers, dry, on an average, from about 70 to 12 per cent. moisture content in 90 days, with practically no defects. Shrinkage to 12 per cent. averages two, or approximately half the normal shrinkage of other wood. In this connection it is of interest to note that contrary to experience with other species, the shrinkage of the heartwood is only about half that of the white sapwood. Average values derived from some thirty test pieces specially cut for the purpose are reflected in the accompanying table.

COMPARATIVE TRANSVERSE SHRINKAGE OF KIAAT SAP- AND HEARTWOOD.

Cut	Shrinkage per cent.	
	Heartwood	Sapwood
Radial	1·5	3·3
Tangential	2·2	4·3
Mixed Grain	1·7	4·6

The samples concerned, which included pieces from ½ to 2 inches thick and 6 inches square, were air-dried for two months and then oven-dried. It is on account of this low shrinkage that warping or distortion in drying is almost entirely lacking, except as might be expected in the tangentially sawn sapwood boards, in which which cupping is not uncommon.

In kiln seasoning from the green, the thinner sizes are readily dried and comparatively severe schedules may be used with impunity. One-inch thick green boards have been dried in 15 days with only 5 per cent. degrade. Temperatures used range from 150 to 160 degrees Farenheit, and humidities of from 60 to 30 per cent. Three steaming treatments were given during the run.

The following treatment for one inch stock containing sapwood has been found from actual experience to be the most economical. Air drying for approximately 6 to 7 weeks, followed by preservative treatment and reloading on kiln trucks for final drying in the kiln for 5 to 6 days. The sapwood treats fairly readily. If heartwood boards only are included, the preservative treatment is, of course, unnecessary.

For thicker sizes it has been found advisable not to dry in wide boards if these are subsequently to be resawn to smaller sizes, such as leg stock. Thick material is difficult to dry and takes proportionately a much longer time. Slightly more rapid drying with fewer defects is obtained if squares are cut from the green.

The main natural defects encountered are small cracks in the centre of the tree which open up in seasoning, and small knot holes. These are not very serious so long as an appropriate rate of drying is observed.

If this is exceeded the wastage due to surface checking may amount to 30 per cent. Thick kiaat boards are especially liable to show these checks between the sap and heartwood zones, and accordingly half-inch piling stickers are now used at Pretoria West instead of the more usual one inch ones. This slows up drying in the initial stages without materially affecting the total time required for seasoning.

Drying tests were carried out over a number of years with plain, waxed and varnished specimens of kiaat, yellowwood, stinkwood, saligna and karri gum, and three species of pine. The tests, which were conducted both indoors and outside under shelter of a verandah, proved that the equilibrium moisture content of kiaat is lower than that for any of the other woods exposed, averaging 7·4 per cent. as against 8·5 for the other species, its variation over the whole period of exposure being only two-thirds of the others. The species included in the experiment are so representative of the marketable South African-grown species that it can safely be assumed that kiaat, at equilibrium, has both the lowest and the least variable moisture content of all.

Properties

The colour of the heartwood varies from brown to dark brown with gold and reddish markings beautifully blended. Some timber shows a purplish colour when freshly cut, but this as well as other unusual colours tones down on exposure to a more or less uniform and very attractive darkish brown. The sapwood is greyish white. The general appearance of the wood is one of bright contrasts. Its weight may vary from 30 to 50 pounds per cubic foot, and averages 41 pounds at 12 per cent. moisture content. Mukwa from Rhodesia has been found to weigh about 7 pounds less per cubic foot. That from Portuguese territory is of approximately the same weight as the South African wood.

The particularly attractive characteristic of the local kiaat is its figure and markings. The logs are usually smaller and not so straight as the imported wood, and show when sawn a never-ending variety of figure as different growth layers are exposed. The accompanying illustration brings out the contrasts in the grain. The imported timber is usually less attractive in this respect and lacks the brightness of he local product.

Large pores give the wood a somewhat coarse appearance and fillers are needed to obtain the best results in finishing.

The heartwood is extremely durable, and withstands the ravages of white ants.

On account of frequent changes in direction of grain, kiaat is not a particularly strong wood, but it has more than ample strength for all the uses to which it is likely to be put. Straight-grained wood has very good strength for its weight. Its hardness makes it very suitable for flooring, and in this respect it is superior to teak.

Structure

The growth rings are not very distinct on the end surface. The pores, which are not very numerous, vary considerably in size, but are mostly large and easily visible to the naked eye, the largest occurring in the early wood. They are rather unevenly spaced throughout the ring, mostly as single pores, but also in groups of from two to occasionally four. Glistening brown infiltrates are present in most of them. Parenchyma occurs round all the pores, but is most obvious as fine tangential lines

which become more continuous as they approach the later wood zone. These bands are about 100 to the inch and consist of two to six tiers. The growth ring is also bounded by a row. These parenchyma bands are very distinct as wavy lines on tangential surfaces, and together with the less obvious but more numerous ripple marks formed by the uniform tiering of the numerous fine rays, are a very characteristic feature of kiaat. See accompanying micro-photo.

Working Qualities

Kiaat works without difficulty by machine or hand. It is harder than teak, but lacks the gritty nature of the latter and is less severe on cutters. It is inclined to rough up slighly in planing, but cuts evenly and bores and mortices without clogging. It makes a good glue joint, turns well and takes varnish readily. It darkens considerably under linseed oil. A very smooth finish can be obtained by scraping. Owing to the wavy nature of the grain it is apt to be brittle on edges. It is very difficult to nail. The working qualities of Rhodesian mukwa are generally much milder and much of the wood can be nailed. The Portuguese wood is similar to that from the Union.

Uses

Kiaat is primarily a cabinet wood, but is also suitable for high-grade joinery, panelling, framing and decorative work of all sorts. The size of the locally grown logs limits its use to designs using the smaller dimensions. Edgings, slabbings and other suitable fall-offs may be turned into strip or parquet flooring, which are priced according to the amount of heartwood included. The use of the wood in the Johannesburg railway station and as dado boards in main line coaches has already been mentioned. Owing to its great durability it can be used for all outside purposes such as garden benches, gates and for numerous other purposes for which imported teak is normally used.

Its low shrinkage makes it particularly suitable for such specialised purposes as bathroom floors, where it is liable to come into contact with water, and printers' furniture, for which stability is particularly desirable. It has been supplied to the State ammunition factory for cartridge case holders. It is an excellent wood for veneer and its use for this purpose is to be encouraged as a means of conserving supplies.

Before the excellent qualities of the wood were fully realised it was wastefully used as sleepers on the mines, and to a lesser extent for naves and felloes.

The mukwa from Rhodesia is used in the manufacture of ration boxes since it is so much softer and takes nails more easily than the timber grown in the Union. The boxes are made from material containing a good deal of sapwood which is treated against borer attack. This may seem a base usage for so beautiful a wood, but the shooks are probably cut from waste material.

Owing to the round logs drying without undue splitting, use is made of short billets for butchers' blocks. Many other uses might be mentioned but sufficient has probably been said to indicate that kiaat is undoubtedly a most valuable wood, not only on account of its handsome appearance, but also on account of its ease of working and seasoning and particularly its unusual stability.

FINISHING

A simple, yet pleasing, method of finishing off articles of furniture, panelling, etc., made from kiaat is the application to their surfaces of a thin coat of some good clear covering such as Water Spar 83/200, the wood having previously been prepared by sanding and scraping to a smooth clean finish, filled if desired in the usual way. After the coat has dried hard the surfaces concerned should be lightly rubbed with very fine sandpaper. A second coat of Water Spar is next applied and allowed to dry and then lightly sanded over. Finally, the surfaces are rubbed up with a good furniture wax polish, such as Dandy, with which should be mixed very finely ground pumice stone in the proportion of $1\frac{1}{2}$ pounds of polish to 2 ounces of pumice stone. For a still more durable finish, three coats of clear Water Spar may be used instead of two. The amount of pumice stone in the wax polish will determine the amount of shine eventually obtained. For a matt finish, the proportion of pumice stone should be slightly increased.

THE RELATIONSHIP BETWEEN MODULUS OF RUPTURE AND WEIGHT IN SOUTH AFRICAN GROWN PINE TIMBER

By JOHN M. TURNBULL

(Forest Products Institute, Pretoria West.)

THE writer has been asked why in an earlier study of variations in strength of pine timber (1) he based his arguments not directly on strength data, but on density. He should have explained this more explicitly. Broadly the reason was because bending strength in pine timber was found to be in very close correlation with density, which submits much more readily to precise measurement. Later work on *Pinus insignis* and, more particularly, *P. teocote* has shown that correlation to be much higher than was at that time realised. *Pinus teocote* as grown in South Africa produces long clear internodes from which it is possible to obtain a very high proportion of clear test material as compared with other pine species, and is accordingly particularly suitable for studies in which a high degree of comparability is desirable.

The power to which density, as represented by specific gravity, should be raised so as to secure proportionality to modulus of rupture under central loading was determined by means of an exponential equation involving the mean values for specific gravity and modulus of rupture at 12 per cent. moisture content for the sixty-seven $1\frac{1}{2}''$ x $1\frac{1}{2}''$ x 23" test sticks lowest, and the 75 highest in specific gravity, out of a total of 142 sticks of this species tested over a span of 21 inches. The general equation is:—

$$\frac{a_1}{b_1^x} = \frac{a_2}{b_2^x}$$

where a = modulus of rupture in lb. per sq. in.
b = specific gravity (volume and weight both at 12 per cent. moisture content.)
x = required power.
and the numbers 1 and 2, the tests or series of tests involved.

In the instance concerned, the ascertained values for the symbols were as follows:—

a_1 = 11,500: average of 75 values.
a_2 = 9,600: ,, ,, 67 ,,
b_1 = .487: ,, ,, 75 ,,
b_2 = .420: ,, ,, 67 ,,

Here:—

$$11500/.487^x = 9600/.420^x$$
$$\therefore x(\log .487 - \log .420) = \log 11500 - \log 9600$$
$$\text{or } x = 1.22$$

The exponent 1.22 may be rounded off to 1.25 to simplify the plotting of the raised specific gravity values. The United States' Forest Products

Laboratory at Madison, it might be mentioned, has adopted 1.25 as the power for correlating the average value of different species (2). Applying this power to the *Pinus teocote* specific gravity values, the average quotient in the expression a/b^x for the 142 values was found to be 28,000, so that for this and, as will presently be seen, certain other species—

$$MR = 28{,}000\ SG\ 1.25$$

where MR = modulus of rupture.
SG = true specific gravity.

It might here be observed that the larger the interval between the values for b_1 and b_1, the more precisely can the exponent be determined By cutting out a number of values round the median so as to increase this interval, substantially the same value for x was obtained. Any gain in precision secured by thus reducing the number of test values in the high and low series is of course neutralised to some extent by a lower reliability in the averages yielded by shorter series, though as will be shown the exponent 1.25 gives estimates remarkably close to actual test values.

Testing of *Pinus teocote* was continued with the results indicated in table 1. The groups, or series, were perfectly random, each representing the values of all tests included on a single computation sheet. It will be noticed that the differences between computed and actual values are lower in series 7 to 11 than in 1 to 6. These last five series represent an absolutely independent application of the formula, which was derived entirely from the data available for the first six.

The closeness of the correlation amongst individual specimens will be seen from table II, in which computed and actual modulus of rupture values for all tests in series 9 are reflected. Results of the application of the formula, using the same constants, to averages of series of previously obtained values of *Pinus insignis* and for previously obtained individual values for *P. taeda* are indicated in tables III and IV. While the quantitative correlation in table IV is obviously lower than that in table II, which also reflects values for individual sticks, qualitatively they are

TABLE I.

COMPARISON OF COMPUTED AND ACTUAL MODULUS OF RUPTURE AVERAGE VALUES FOR 11 GROUPS OF PINUS TEOCOTE.

Group	No. Tests	Mean modulus of rupture 100 lb. per sq. in.		Difference per cent.	Remarks
		Estimated	Actual		
1	30	105	103	2	Individual data of first six groups used in determining x.
2	30	108	105	3	
3	25	100	104	4	
4	15	106	109	3	
5	22	105	109	4	
6	24	107	108	1	
7	23	103	104	1	Data for groups 7 to 11 obtained subsequent to 1 to 6.
8	20	103	103	—	
9	22	98	99	1	
10	22	100	101	1	
11	16	107	109	2	
Average	**249**	**104**	**105**	**1**	

TABLE II.

COMPARISON OF INDIVIDUAL VALUES IN GROUP 9.

Test No.	Modulus of rupture		Per cent. difference	Remarks
	Computed	Actual		
1	95	93	2	
2	87	88	1	
3	90	89	1	
4	102	101	1	
5	99	92	7	
6	78	78	—	
7	103	106	3	
8	111	113	2	
9	87	97	12	
10	113	125	11	
11	105	112	7	
12	97	107	10	
13	96	90	6	
14	93	96	3	
15	105	109	4	
16	83	74	11	Heart wood included
17	100	101	1	
18	113	111	2	
19	115	127	10	
20	88	88	—	
21	92	82	11	Very spirally grained
22	112	99	12	Very spirally grained
Average	98	99	1	

very similar, their "correspondencies" being .82 and .80 respectively. See note on qualitative analysis at end of this paper.

Analysis of the percentage differences between computed and actual modulus of rupture is given in table V, from which it will be seen that in three quarters of the tests the difference did not exceed ten per cent., and in half of them, five per cent.

TABLE III.

Pinus insignis: 16 GROUPS.

Group	No. tests	Modulus of rupture		
		Computed	Actual	Per cent. difference
1	27	126	116	8
2	25	124	122	2
3	24	125	116	7
4	19	129	125	3
5	20	126	120	5
6	17	122	112	8
7	21	141	138	2
8	20	145	140	3
9	22	131	128	2
10	20	139	135	3
11	21	133	139	5
12	18	138	143	4
13	21	137	138	1
14	17	147	148	1
15	22	133	140	5
16	31	116	114	2
Average		131	128	2

There seems to be no doubt from tables I to V that weight exercises an overwhelming influence on transverse strength of pine timber grown in

TABLE IV.

Pinus Taeda: INDIVIDUAL VALUES.

Test No.	Modulus of rupture		Percentage difference
	Computed	Actual	
1	125	108	14
2	87	82	6
3	112	111	1
4	127	151	19
5	89	84	6
6	114	122	7
7	120	130	8
8	91	85	7
9	128	142	11
10	141	166	18
11	97	91	6
12	133	128	4
13	113	113	—
14	127	137	8
15	125	123	2
16	120	111	8
17	111	87	22
Average	115	116	1

South Africa. In countries to which pines are indigenous a large proportion of heartwood occurs in timber of utilisable size, and trees young enough to be more or less free of heartwood, in view of a lower rate of growth than obtains in South Africa, are too small to yield satisfactory test material. Varying proportions of heartwood and of the infiltrates present

TABLE V.

ANALYSIS OF DIFFERENCES BETWEEN COMPUTED AND ACTUAL MODULI OF RUPTURE OF 232 SPECIMENS OF *Pinus teocote*.

Per cent difference	Frequency	Percentage cumulative frequency referred to each difference	
		Below	Above
0	18	0	100
1	25	8	92
2	23	19	81
3	25	28	72
4	20	38	62
5	17	47	53
6	11	54	46
7	22	59	41
8	7	69	31
9	5	72	28
10	15	74	26
11	12	81	19
12	5	86	14
13	4	88	12
14	5	90	10
15	3	92	8
16	2	94	6
17	5	95	5
18	2	97	3
19	1	98	2
20	—	98	2
21	—	98	2
22	2	98	2
23	1	99	1
24	—	99	1
25	—	99	1
26	2	99	1
27	—	100	0

therein, the additional weight of which seems to be non-contributory to strength, tend to mask the strength potentiality of the mass or density of the primary woody tissue. For these reasons it would be unwise to assume that the close correlation that exists in South Africa between strength and a function of weight is of general application to pine timber grown elsewhere; in fact, the writer has been informed by authoritative sources in other countries that the closeness of the correlation in South African pine timber is exceptional.

In South Africa, therefore, where so easily and precisely measurable a property as density, in certain species at least, is in very close correlation with transverse strength, a method of approach to certain timber investigational problems is indicated, the possibilities of which deserve the fullest exploration. Nor must it be assumed that, because such a method may not be so applicable in other countries, conclusions arrived at by its use here will not hold good elsewhere. Up to the present it has been usual to study the effects of environmental factors on strength of timber by means of direct strength tests. Now, if strength and density in pine timber grown in South Africa were in absolute correlation, and if it may be assumed that the only hindrance to the occurrence of such correlation elsewhere is the presence in the timber of material whose weight is non-contributory to strength, the strength of such timber would be in absolute correlation with the density of South African grown timber of equal strength, and therefore an analysis of the variance of density in South African grown timber would be interpretable elsewhere in terms of strength.

The chief difficulty in studying the strength variations of South African grown pine timber lies in the knottiness of the small sized stems that in most species at present only are available. In few stands has any considerable zone of clear wood been imposed upon what in pruned timber would be regarded as the economic peripheral limit of the knotty core. The practice of pruning in South Africa, indeed, is of so recent introduction that the whole stem in existing stands might almost be regarded as knotty core.

Standard procedure in testing is to test sticks sawn out of logs to a cruciform diagram, as represented by the hatched squares in figure I, and to evaluate the strength of the log at a given point in its length by averaging the test values of the sticks constituting the diagram. In South African grown pines, knottiness precludes completion of the diagram within reasonably small ranges of length, and blinds, or defective sticks, even affect the representativeness of complete utilisation of the cross-section of logs. This difficulty is illustrated in figure 1, in which the standard pattern and complete utilisation are both indicated. Blinds are represented by the black squares. The incidence of the blinds on the representativeness of the average values varies indirectly with the diameter of the logs concerned, as the proportion of clear wood usually, even in unpruned stems, increases radially outwards. It should be explained that the height range at which stems are sampled affects comparability of the resulting sticks.

If attention is focussed on the specific gravity of the sticks constituting the standard diagram, instead of on strength, its evaluation can be made by measuring and weighing clear pieces of wood a few cubic inches in volume, and as it is always possible to secure the full standard diagram of such material within a very short range of log length, averages of values at any vertical position in logs will be perfectly representative of their cross-section. Moreover as cross, wavy, and spiral grain, and defects

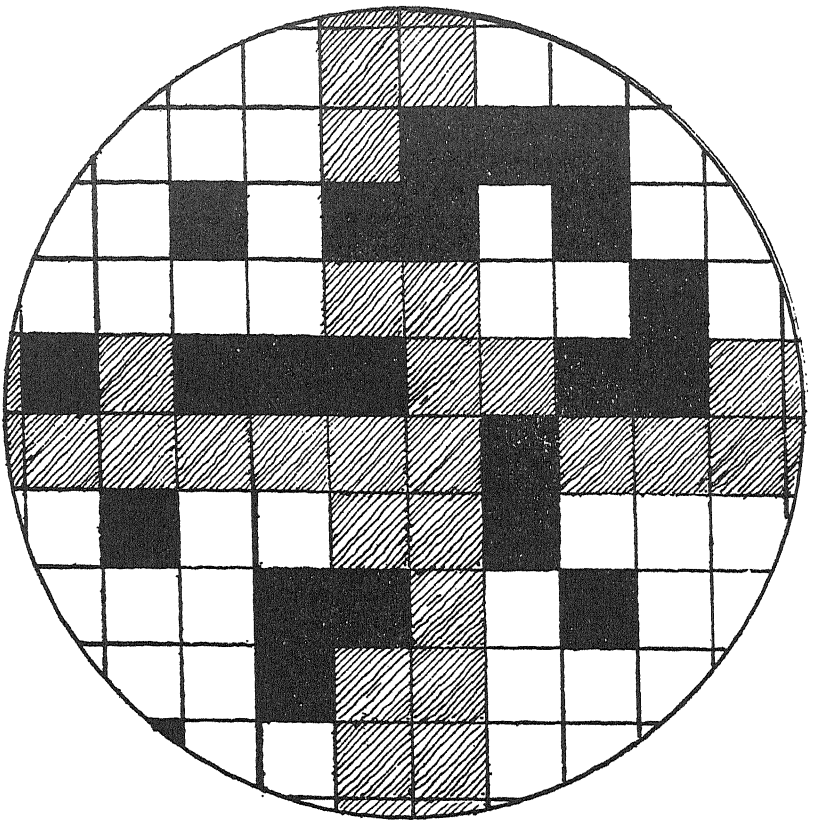


FIG. 1.—Distribution of clear test material over log cross-section.

of certain other natures do not influence weight, specific gravity values can be converted to the moduli of rupture that would apply to material of maximum comparability.

More intensive investigations such as the influences of certain factors of environment on the strength of wood formed within a given number of years is facilitated by density comparisons to a still greater degree, or, indeed, only thus made possible.

In even-aged logs of varying diameter it is of course impossible to cut test sticks of the same size each including the same range of annual rings, a desideratum in sticks forming the basis of environmental studies. If cut to include an equal range, some sticks will be too small in cross-section to submit with any degree of precision to strength measurement by approved strength testing machinery. It has been found that although tests on sticks of $1\frac{1}{2}'' \times 1\frac{1}{2}''$ section yield strength: specific gravity ratios inappreciably less consistent than standard $2'' \times 2''$ sticks, that applying to $1'' \times 1''$ sticks is markedly erratic. Their variable size again will call for frequent adjustment of testing equipment and will augment the tedium of computation by necessitating working in each case from the general formula for modulus of rupture instead of from a special formula in which fixed dimensions have been provided for. Then there

is also the insuperable difficulty of sawing so as to maintain the same group of rings at both ends of, or throughout, the test sticks. It will be clear how these difficulties may be obviated by using short pieces of wood such as are adequate in size when specific gravity is taken as a criterion for comparison instead of direct strength values, for the shorter the specimens the lower will be the range of length within which 100 per cent. of clear wood can be sawn out of a transverse diagram, and the lower will be the deviation at one end of each specimen from the group of growth rings included at the other. Savings in material and in its transport and preparation for these intensive investigations are also important points in favour of the density method. Instead of logs, all that is required from the field will be transverse discs, a few inches thick, cut at specified heights in the felled stems, the remainder of which will be available for disposal otherwise.

Although fixed constants C and x, in the equation—

$$MR = C(SG)^x$$

may not apply to all pine species, and there are indications that they do not apply to *Pinus pinaster*, it is very unlikely that a high correlation between transverse strength and density will not be found in trees of any species of pine. Assuming the correlation does affect all species, any changes in constants for particular species need not deter investigation into environmental influences on a density basis, although it would still be advisable for purely objective strength studies to utilise a proportion of the material for verification of the specific gravity/modulus of rupture ratio by direct strength tests. For environmental studies in connection with a particular pine species, whatever constants may be applicable, another advantage accrues from the use of density. Selection of material for such studies, to secure maximum precision in the interpretation of results, should be based on statistical principles. Where standard test sticks have to be cut, the codification of sampling procedure becomes complicated by the varying incidence of blinds in a saw diagram. To eliminate the resulting uncertainty an overwhelming volume of material is necessary to ensure by replication that every radial position in logs is adequately represented in the aggregate. In using short specific gravity blocks, every transverse position can be sampled and thus replication for biometrical elimination of complexities arising from the occurrence of blinds greatly reduced.

Figure 2 is a frequency curve representing the number of test sticks of *Pinus teocote* falling within successive specific gravity groups, smoothed by the plotting of the moving averages of successive groups of four frequencies. The interruption of the curve's continuity between groups .45 and .49 would appear to be due to the discard of a disproportionate number of defective sticks from the portion of the diagram that would normally conform to these groups of values, and it is re-entrants such as this that it is hoped to eliminate by substituting a specific gravity for a tested modulus of rupture basis, and thus ensure a more reliable indication of sampling requirements. Without a thoroughly representative frequency curve no satisfactory sampling code can be devised, and without such a code little headway can be made with investigation of the amazing regional variations in density and strength that characterise so important a South African timber crop as, for instance, *Pinus patula*.

In order to determine whether the formula applies uniformly at any radial position, the quotients MR/SG^x for sticks cut from all flitches sawn radially at each side of the pith were assembled in two groups, inner

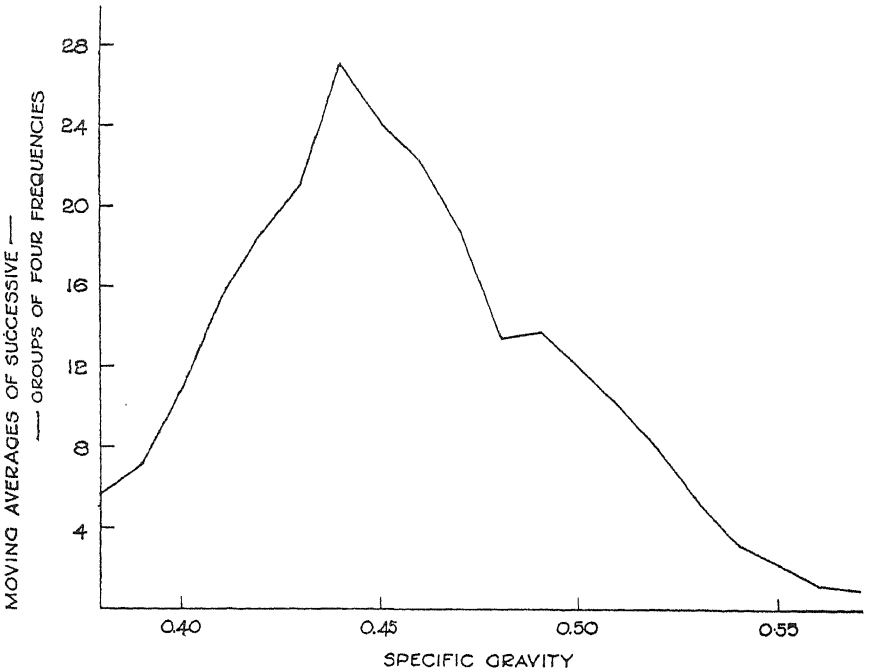


FIG. 2.—Frequency distribution of specific gravity groups of 250 test specimens of *Pinus teocote*.

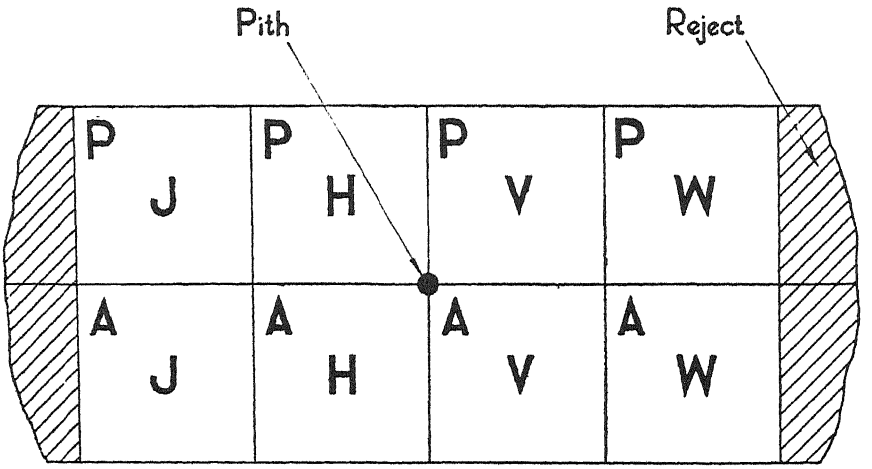


FIG. 3.—Cross-section of adjacent radial flitches diagrammed for sawing of test specimens, illustrating experiment designed to demonstrate radial uniformity of modulus of rupture/specific gravity ratio.

and outer, that is, positions HV and JW, respectively, in flitches A and P, as shown in figure 3. The hatched portions of the diagram, marked "reject," actually yielded a few sticks, but so few that they have been ignored for purposes of comparison, and values HJVW only considered. The quotients in 63 H and V sticks averaged 28,200 and in 34 J and W sticks, 23,300. Radial position, with which is associated developmental age, would thus seem to have no bearing on the strength/density ratio, and may accordingly be ignored in any comparison of values for pine timber.

TABLE VI.

APPROXIMATE MODULUS OF RUPTURE AT 12 PER CENT. MOISTURE CONTENT OF TIMBER OF CERTAIN PINE SPECIES CORRESPONDING WITH GIVEN SPECIFIC GRAVITIES AND WEIGHTS PER CUBIC FOOT.

Lb. per cu. ft.	Specific gravity		Modulus of rupture	Lb. per cu. ft.	Specific gravity		Modulus of rupture
	Conventional*	True			Conventional*	True	
16	.22	.25	5,000	30	.43	.48	11,200
	.23	.26	5,200	31	.44	.49	11,500
17	.24	.27	5,500		.45	.50	11,800
	.25	.28	5,700	32	.45	.51	12,100
18	.26	.29	6,000		.46	.52	12,400
19	.27	.30	6,200	33	.47	.53	12,700
	.28	.31	6,500	34	.48	.54	13,000
20	.29	.32	6,700		.49	.55	13,300
21	.29	.33	7,000	35	.50	.56	13,600
	.30	.34	7,300	36	.51	.57	13,900
22	.31	.35	7,500		.52	.58	14,200
	.32	.36	7,800	37	.53	.59	14,500
23	.33	.37	8,100		.54	.60	14,800
24	.34	.38	8,400	38	.54	.61	15,100
	.35	.39	8,600	39	.55	.62	15,400
25	.36	.40	8,900		.56	.63	15,700
26	.37	.41	9,200	40	.57	.64	16,100
	.38	.42	9,500	41	.58	.65	16,400
27	.38	.43	9,700		.59	.66	16,700
	.39	.44	10,000	42	.60	.67	17,000
28	.40	.45	10,300		.61	.68	17,300
29	.41	.46	10,600	43	.62	.69	17,600
	.42	.47	10,900	44	.63	.70	17,900

*Standard laboratory usage. Actually equivalent to ratio between weight oven dry and volume at time of test.

In table VI is given the modulus of rupture equivalents against specific gravities .25 to .70 at specific gravity intervals of .01. The integral weight in pounds per cubic foot corresponding to each of these specific gravities is also given. The latter may be of some use to users of pine timber as a guide to rejection of pieces that fall below the strength requirements of particular designs.

The incidence of this classification on the derivation of safe working loads has still to be investigated. An important component in a safety factor for timber is the allowance made for variation in test values. As the strength of South African grown pine timber is so closely associated with weight, however, timber in a narrow weight class will vary but little in strength, and the variance component applicable to timber of a specified minimum weight may accordingly be considerably reduced.

APPENDIX

Qualitative Analysis

Qualitative analysis referred to on p. 69 is a statistical tool that the writer has found of use in roughly but rapidly determining the degree of correspondency in the fluctuations of values for two different properties or characteristics in respective samples. The procedure is to set down the values for the two characteristics in parallel columns, those applying to the same sample opposite each other. Figures denoting the order of magnitude of values in each column are next noted on the right of each column and the difference between the order of magnitude finally noted. The sum of the final column is then deducted from half the square of the number of samples, or, if the square is odd, unity is deducted before halving. The difference divided by half the square of the number of samples is the coefficient of correspondency. Thus:—

Sample No.	Value of characteristics				Difference in order A and B, or departure
	A		B		
	Value	Order	Value	Order	
1	26	9	692	10	1
2	38	8	1000	9	1
3	24	10	1340	8	2
4	46	7	2810	6	1
5	83	4	2220	7	3
6	69	6	3102	4	2
7	83	5	3000	5	–
8	94	3	4500	3	–
9	148	1	6200	2	1
10	130	2	6400	1	1
10					12

Highest possible aggregate departure, i.e. half number of samples squared = $10^2/2 = 50$.
Aggregate departure = 12.
Difference = 38.
Coefficient of correspondency = 38/50 or .76.
which is high.

When two or more values in either column are equal, for instance values for A5 and A7, the order should be adjusted to the trend of the corresponding values in the other.

Summary

The function of specific gravity to which modulus of rupture of the timber of certain South African grown pine species is directly proportional is determined from test data on *Pinus teocote* material. The ratio between this function and modulus of rupture tends towards constancy to an extent that invests specific gravity with value as a criterion of strength in certain respects superior to that of direct strength tests. The ratio appears to apply to wood of any radial position. By use of this ratio a table is compiled reflecting the estimated modulus of rupture corresponding to weight in pounds per cubic foot and specific gravity at intervals of one and .01, respectively.

REFERENCES.

1. TURNBULL, JOHN M.: Variations in Strength of Pine Timbers. *South African Journal of Science*, Vol. xxxiii, March, 1937, pp. 653/682.
2. MARKWARDT, L. J., and T. R. C. WILSON: Strength and Related Properties of Woods Grown in the United States. United States Department of Agriculture, Technical Bulletin No. 479, Sept., 1935.

CORRESPONDENCE

THE VALUE OF AN IMMATURE PLANTATION

To the EDITOR

Sir,

In Mr. O'Connor's article in your last issue on "The Value of an Immature Plantation," the Magistrate, inspired by Mr. A's evidence, awards damages to the claimant on the basis of mean forest per cent., in this case over 40. This does not seem equitable. All that the claimant loses is the use of his land plus the cost of establishing and tending his trees, both compounded at an assured rate of interest. The anticipated final return of £48·5 per acre is quite problematical, and even if guaranteed by insurance against all conceivable risks, the aggregate duly compounded premiums would absorb the difference between a safe return from a low dividend paying investment and an anticipated return from forestry discounted back to the calamitous year at the mean forest per cent.

The claim for the present value in the fourth year might be substantiated if the claimant's investment compounded at a reasonable rate of interest, say 5 per cent., could be proved to mature at that amount. In that event the cost value in the fourth year would equal the expectation value. To satisfy this condition the land would have to be worth £91·5 per acre, and the value of the investment less the value of the land, that is, the claim, £23·7. Such a claim, of course, could not be upheld without expert support of the valuation of the land, which in this instance would hardly be forthcoming.

Yours faithfully,

LAIRD.

"Laird's" criticism of the Magistrate's judgment has been shewn to Mr. O'Connor, who has kindly furnished the following reply.—*Editor.*

Laird says (a) the claimant lost only the use of his land plus the cost of establishment, both compounded at an assured rate (5 per cent. ?) of interest and (b) the anticipated final return was quite problematical. As regards (a), the defendant held a similar view, which he was unable to maintain against the arguments advanced by the claimant. As regards (b), the final return was not in dispute at all. Reading his two statements together one concludes that Laird denies the validity of any assessment based on expectation value.

He says further that even if the final return could be guaranteed by insurance, the aggregate premiums would absorb the difference between a "safe return from a low dividend paying investment and an anticipated return from forestry at the mean forest per cent." Well, now, let us call 5 per cent. a safe return and, to guarantee the final return, let us insure and add to the original initial cost (£3·25 per acre) the initial value of all insurance premiums such that the mean forest per cent. becomes 5 per cent. The initial investment will then be £32·83 per acre, the value of which increases at 5 per cent. to £48·5 per acre in the eighth year. In the fourth year the value is £39·9 per acre. Laird, while he main-

tains that the judgment granting the claimant compensation at the rate of £12·55 per acre (representing over 40 per cent. interest) was unjust to the defendant, nevertheless implies that compensation at £39·9 per acre would have been quite fair because the rate of interest in this case would have been no more than 5 per cent.

I am afraid I do not see the relevancy of the remark that the investment would have earned 5 per cent. compound interest if the value of the land was £91·5 per acre. The value of the land is its market value. How does the land enter into the calculation anyway unless the growing of the trees or their destruction altered its market value?

PRESERVATION OF INDIGENOUS FORESTS

To the EDITOR

Sir,

Many people have read with much interest the exhaustive survey of the indigenous forests of South Africa by Mr. N. L. King, which appeared in your issue for April last, under the heading " The Exploitation of the Indigenous Forests of South Africa." The picture drawn by Mr. King of the destruction of our indigenous forests is deplorable. Of 281,000 acres of first-class forest about 77 per cent. is said to have been overworked, including about 28 per cent. reduced to "kreupelbos." Of forests more or less intact, the Union's total possessions amount to a meagre 14,750 acres. Thus the bulk of our true forest has already been mutilated and must be handed on to posterity in this condition. Surely steps can be taken now to prevent any further exploitation of the few forests which have not been reduced to this condition.

In America the redwoods of California have been preserved for the nation. In Australia the State has preserved many of the giant eucalypts. In New Zealand the kauri pines in North Island have been saved from exploitation. And just as steps are being taken in the Union to-day by the Historical Monuments Commission to preserve for posterity our Bushmen drawings and other relics of the past, so we should preserve what remains of our yellowwood trees in the few remaining forests which are to-day unexploited or have been only lightly culled. In making this appeal I feel sure that I shall have the wholehearted support of the Division of Forestry.

The quantity of timber contained in these forests and the revenue to the State seems to me entirely insignificant when viewed from the broader aspect of preserving these forests as a national heritage. As Mr. King so rightly points out, if now tampered with they can never be restored to their original condition.

Yours faithfully,

H. A. READ.

INTRODUCTION OF *POPULUS DELTOIDES* TO SOUTH AFRICA

To the EDITOR

Sir,

From the article "The Growing of *Populus deltoides*," by E. I. Schiemer, which appeared in your 5th issue, I note that the origin of this species in South Africa has not apparently been traced and it may be of interest to readers to know that, in his report for the year 1878,

the Superintendent of Plantations for the Cape, J. Storr Lister, who, after Union, became Chief Conservator of Forests, states :—

> Out of the 2,000 cottonwood cuttings obtained from America, only a few had any vitality in them; of these, notwithstanding the most careful treatment, but two have survived. These two have attained a height of several feet. Some of the leaves are four inches in breadth. In a short time a further supply of cuttings may be procurable from this source.

Possibly these cottonwoods were the first to be introduced to South Africa and it is from them that the extensive plantations of *Pop. deltoides* in the Union may have originated.

Yours faithfully,

S. St. C. BALLENDEN.

DESTRUCTION OF NATIVE TREES BY LANDOWNERS

To the EDITOR

Sir,

I send you herewith a photo depicting what can only be described as wanton destruction, a large native tree fagoted round preparatory to firing. I wonder how long acts of this nature will be allowed to continue. At present if a man owns a farm he is at liberty to dig up trees that have taken centuries to grow. He can even, if he have water, sluice all the soil off it, without giving a thought to coming generations. There is no law to stop him. The tree shewn reminds one of the Christian martyrs bound to the stake in readiness for the flames. The job is too big for mattock and shovel, and hence the piled fagots.

If the Forestry Department has no control over acts of this kind, it is high time it had. Could not we, as an Association, influence the introduction of legislation whereunder a farmer, even on his own land, can cut down natural forest only under Government permit? The land in the present instance will in all probability be used for planting saligna. Another portion of the same farm has already been mutilated for this very purpose. The saligna crop would not have been any less had those trees been left standing.

Yours faithfully,

LITA.

" Lita's " letter has been transmitted to the Director of Forestry, who has kindly furnished the following statement on the legal aspect of this matter.

The new Forest and Veld Conservation Act provides that whenever, in respect of any land not being a Crown forest, the Governor-General deems it expedient in the public interest that any tree or the whole or any part of a forest or plantation shall be protected, he may by proclamation declare such tree or forest or plantation to be protected. Thereafter no person may cut, injure or destroy any tree so protected or any tree in such protected forest or plantation without the written consent of the Minister and then only on such conditions as he may determine. Where conditions imposed by the Minister are so onerous as to result in patrimonial loss, the owner will be entitled to compensation, except where the trees concerned are recognised fodder trees.

In accordance with the terms of this provision of the law, the Governor-General has recently, at the request of the local Farmers'

Associations, proclaimed the well-known fodder trees and shrubs of Griqualand West and adjoining districts and also, in deference to general public opinion, the baobab tree of the Northern Transvaal.

Action under the relevant provisions of the Act is straightforward and the control to be exercised by the Department with respect to protected trees need present no peculiar difficulty, nor is there any reason why restrictions to be imposed by the Minister need be unduly onerous to the owner or interfere substantially with his rights. It is, however, desirable that action taken with regard to the proclamation of any trees should rest on the support of public opinion, as it is only when such support is forthcoming in the shape, for instance, of a resolution passed by the local public body or by a farmers' or other association, that there will be proof of the realisation of the benefits of the law and of the need for applying its provisions. Without this the mere act of proclaiming a tree to be protected will not, in such a wide country as South Africa and with a population notably impatient of any curtailment of rights in private property, achieve the objects desired.

In many parts of the country farmers (and even natives in the locations) are more and more adopting the practice of leaving shade or ornamental trees in the clearing of land for cultivation of agricultural crops, and it is to be hoped that the plantation owner may feel induced to follow this example — even if only to afford a shelter and lair for birds and game.

SUPPLY OF SNAKE-BITE SERUM FOR THE FORCES

To the EDITOR

Sir,

This Institute is having to meet greatly increased demands for Antivenene (Snake-bite Serum) for the Union Forces in the field and for all non-enemy African States, some of which latter formerly drew their supplies from the Pasteur Institute in Paris.

To meet this demand we must procure greatly increased supplies of Cape Cobra and Puff Adder venoms. Up to recently our sources of supply have been from snakes collected and drained of venom by the snake parks at Port Elizabeth and Cape Town and from snakes received at the Institute, but we now require three or four times the amount so collected.

It has occurred to us that members of the S.A. Forestry Association might be brought to interest themselves in collecting live full-grown snakes of the two species mentioned and to have them sent to either of the above-mentioned snake parks or to the Institute. Such snakes received alive and in good condition (the fangs particularly being undamaged) would be paid for at ruling rates, i.e., from 4s. to 7s. 6d. according to size. For the journey the snakes should be placed in a sack to prevent damage and then in a wooden box.

Would it be possible for you to assist us in this emergency by bringing this appeal to the notice of your readers?

The cold season is now over and collections might be started at once.

Yours faithfully,

E. H. CLUVER,

Director, The South African Institute for Medical Research.

Hospital Street, Johannesburg.

REVIEWS

THE SUITABILITY OF SUPPORTS USED UNDERGROUND ON THE WITWATERSRAND. By *J. W. Bowen, M.Sc.* The Journal of the South African Institute of Engineers, February, 1941. Reprint.

This paper contains a mass of valuable information regarding the compressive resistance of stope supports of widely varying design and material. In wooden mat packs the effects of species, type of wiring, rise, number of pieces, open and solid construction, and a number of other technical alternatives are contrasted. Concrete is compared with wood greatly to the disadvantage of the former, so much so, indeed, that Mr. Bowen expresses concern regarding the future of the concrete disc manufacturing plants installed at fairly large expense at certain mines. In his general conclusion, Mr. Bowen observes :—

> As poles above 9 in. diameter withstand greater loads than concrete discs of 24 in. diameter, and as timber poles prove equally as satisfactory as concrete discs for most purposes, there appears to be no reason why timber cannot be used instead of concrete.
>
> In the case of small waste-filling in open timber packs it is doubtful whether the smaller compression at lower loads justifies the use of stone-filling when ordinary timber packs give much better load compression ratios.
>
> In view of the high load/compression ratios of solid timber packs it appears possible to build timber packs to correspond to the load/compression ratios of any other type of support used underground. Although the majority of timber packs are 2 ft. sq., there is no reason, other than economy, why they could not be built of greater dimensions to take correspondingly greater loads.

The final paragraph in the above quotation embodies a principle that might well have far-reaching effects on the development of support technique. The graphs resulting from the mat pack tests, load on vertical compression in a selected design, moreover, may prove of great value as a basis for the mapping of stope pressures. In this connexion, Mr. Bowen observes, "there is no doubt that very considerable economies could be introduced if mine managers were certain that the support used was adequate." The tests were performed at the Mechanical Laboratory installed by the Mines Department at Cottesloe in 1937, where alone the huge mechanically controlled stresses required for the investigation could be made available.

The use of the terms "saligna" and "gum," unless they represent established mining terminology, is undesirable. Saligna is a gum, and accordingly "saligna gum" and "other gums" are preferable.

The table illustrating the effect of pole diameters on compressive strength is interesting. The strength of wattle is shewn to be more or less constant radially. It is a pity the number of tests on which each value in these tables was based is not recorded, for those for saligna include apparent anomalies that might have been considerably modified had the

tests been adequate in number. An 11-inch saligna log, for instance, is recorded as supporting a load of 160 tons, and a 12-inch one, 386 tons. Were this increase in strength due entirely to the superior strength of the one inch peripheral ring of wood imposed after formation of the inner 11 inches, the cross section of a log composed of such wood would support approximately 1,400 tons, which is inconceivable. Mr. Bowen attributes the increased strength of the larger log to the maturing of the wood, by which it is assumed is meant increase of diameter with age. Maturing in any other sense does not materially affect strength in eucalypt timber. Timber formed within any extent of radial growth does not alter in strength after additional wood has been imposed. In any tree stem, the same stem at all earlier ages is incorporated, and these do not vary appreciably in properties. The difference in strength between Mr. Bowen's 11 and 12-inch logs is more likely attributable to difference of growth environment or to botanical strain. By the time mining timber from various sources is delivered at the mines, it is normally too mixed up to permit of identification to the extent necessary to ensure comparability in the many respects affecting strength. If the material for the tests had been specially selected and segregated with an eye to comparability, the large differences shewn by the saligna would almost certainly not have been revealed. The density and strength of saligna grown in South Africa, it is well known, varies remarkably, regionally, with age and, fortuitously, in the same even-aged stand. For these reasons Table ii should not be taken as a guide in determining the most desirable prop diameter for a particular job.

Mr. Bowen, in the section headed "Concrete Discs", suggests that the compressive strength of concrete cannot be expressed in terms of unit superficial load. If this interpretation is correct, the contenion seems to call for elaboration or confirmation by experiment.

The industry and resourcefulness that has been expended on this investigation are a credit to the author of the paper, who is further to be congratulated on the manner in which their results have been marshalled.

A Cross-Shaft Overhead Fan Kiln. Forest Products Research Laboratory Leaflet No. 18. Princes Risborough, 1941.

This leaflet describes yet another type of internal fan kiln, which, on account of its simplicity of construction alone, deserves careful consideration.

The building is constructed with brick cavity walls and concrete floor and ceiling, the inside dimensions of which, to ensure maximum efficiency, should not exceed 10′ in width and 13′ 3″ in height. Length may be anything up to 14′ or even more. This compartment may be charged with a load of timber not exceeding 7′ in width, 8′ in height, by the full length of the compartment.

A false ceiling is suspended immediately above the load providing ample space for heating coils, fans, ventilators and other equipment. Heat is supplied by 34 one-inch steam pipes if softwoods are to be dried, and 20 for hardwoods.

The most interesting feature of the kiln is the method of creating air circulation by means of cross-shaft overhead fans. These are 3′ in diameter and are spaced horizontally at 6′ to 8′ centres along the upper portion of one side wall. Each fan is carried on a 5′ 6″ shaft which

protrudes through the wall, on the outside of which they are coupled together with pulleys and belting. One motor will suffice to run the fans at the correct speed of 500 r.p.m., and direction may be changed at will.

A steam spray pipe is provided for steaming the load when required, and for humidifying the air when necessary during the drying period. To get rid of excess moisture, on the other hand, 6″ diameter outlet chimneys are arranged in a row in front of the fans, which work in conjunction with a similar row of inlet chimneys immediately behind them. At the latter place is also installed a deflector which greatly facilitates reverse circulation.

Good use can no doubt be made of additional deflectors to direct currents with less friction to the load, and a baffle plate appears desirable to prevent too much air passing under it.

If more than two of these kilns are installed in series, some difficulty will be experienced with the protruding shafts, which could be overcome, however, by a change in roof construction.

It is believed that this kiln under efficient operation will yield stress-free timber seasoned to any moisture content desired, and its simpler design is an advantage of great importance.

N.B.E.

INTERCEPTION AND STEMFLOW IN A PINE PLANTATION. By *J. Kittredge, H. J. Loughead* and *A. Mazurak*. Journal of Forestry, Vol 39 No. 6, 1941.

Data of rainfall interception and stemflow (stem run-off) collected in a stand of *Pinus canariensis* C. Smith at Berkeley, California, U.S.A., are presented in this paper. South African forest officers will be interested in the account, because it deals with the effects of a stand of one of our major plantation species growing in a climate resembling that of the South Western Cape Province. The paper is also of value because of the details given of the technique of gauging interception and of the methods of analysing interception data.

The two plots on which measurements were taken were densely stocked. They carried 600 and 760 trees per acre respectively at the age of 28 years when the mean height was 37 feet and mean diameter at breast heights 6.6 inches. Observations were confined to rainy seasons from 1932 to 1939. It was found that trees on the plots intercepted between 17 and 28 per cent. of the season's precipitation, of which only one per cent. was returned to the soil as stemflow.

Observations were made inside the stand and at points 80 and 180 feet distant in the open. This method is, however, subject to errors caused by wind eddies over the gauges in the open and by changes in the local distribution of rainfall due to the obstruction offered to wind by the stand of trees. For these reasons interception figures expressed as percentages of rainfall in the open will have to be accepted with some reserve.

Interception was caused by placing rain gauges on lines radiating from the tree boles, and determining the interception for separate zones at increasing distances away from the boles After ascertaining the areas of the zones on the experimental plots the interception in the stands could be determined. Precipitation was dealt with by individual storms and a useful storm classification based on volume of downpour per storm

was devised. Stemflow was converted to percentage of precipitation by using a converting factor based on crown areas of sample trees. This method was compared with others. It is surprising that stemflow was not found to be related to crown-length, density, tree height, basal area or crown area, all of which are dependent on the tree size. This may possibly have been due to large chance errors influencing the small amounts of stemflow measured.

The careful analyses and explanations of variations in stemflow and interception with different locations of gauges with respect to stems, crowns and openings makes the paper an important contribution to the sudy of precipitation in pine plantations.

C.L.W.

PUBLICATIONS RECEIVED

Receipt of the following publications is acknowledged with thanks:

CANADIAN RESOURCES BULLETIN, No. 229, August, 1941.

EMPIRE FORESTRY JOURNAL, THE. Vol. 20, No. 1, 1941.

MALAYAN FORESTER, THE. Vol. X, No 2, April, 1941.

PHILIPPINE JOURNAL OF FORESTRY, THE. Vol. 3, Nos. 3 and 4, 1940. Vol. 4, Nos. 1 and 2, 1941.

PINHOLE OR POWDER-POST DAMAGE. Forest Products Research Leaflet No. 17. Princes Risborough, 1941.

SCOTTISH FORESTRY JOURNAL, THE. Vol. 55, Part 1, March, 1941.

Die

Tydskrif van die Suid-Afrikaanse Bosbouvereniging

April

UITGEGEE DEUR DIE VERENIGING
April en Oktober

The

Journal of the South African Forestry Association

April

PUBLISHED BY THE ASSOCIATION
April and October

No. 8. *1942*
PRETORIA
6/-

SUID-AFRIKAANSE BOSBOUVERENIGING.

Beskermheer:

SY EKSELLENSIE DIE GOEWERNEUR-GENERAAL,
DIE HOOGEDELAGBARE SIR PATRICK DUNCAN,
G.C.M.G., K.C.

President:

DIE EDELAGBARE KOLONEL DENEYS REITZ, L.V.

Vise-Presidente:

DIE EDELAGBARE KOLONEL W. R. COLLINS, L.V., D.T.D., D.S.O.

HANS MERENSKY, DR.ING.H.C., D.SC.

H. J. VAN DER BIJL, D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.

P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.

C. E. LEGAT, C.B.E., B.SC.

J. HUNT HOLLEY.

T. M. MACKENZIE.

AMPSDRAERS:

Voorsitter: J. D. KEET, DIP.FOR., M.SC. (ERE.)

Ere Redakteur: J. M. TURNBULL, DIP.FOR.

Ere Sekretaris-Tesourier: D. R. DE WET, B.SC., L.I.K.B.

Uitvoerende Komitee:

J. D. KEET, DIP.FOR.,M.SC. (ERE.), (*Voorsitter*)

I. J. CRAIB, M.F., PH.D.

H. A. LORENTZ, LL.D.

PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.

J. M. TURNBULL, DIP.FOR. (*Ere Redakteur*)

D. R. DE WET, B.SC., L.I.K.B.

SOUTH AFRICAN FORESTRY ASSOCIATION.

Patron:

HIS EXCELLENCY THE GOVERNOR-GENERAL,
THE RIGHT HON. SIR PATRICK DUNCAN, G.C.M.G., K.C.

President:

COLONEL THE HONOURABLE DENEYS REITZ, M.P.

Vice-Presidents:

COLONEL THE HONOURABLE W. R. COLLINS, M.P., D.T.D., D.S.O.
HANS MERENSKY, DR.ING.H.C., D.SC.
H. J. VAN DER BIJL, PH.D., D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF,
P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.
C. E. LEGAT, C.B.E., B.SC.
J. HUNT HOLLEY.
T. M. MACKENZIE.

OFFICERS:

Chairman: J. D. KEET, DIP.FOR., M.SC. (HON.)
Hon. Editor: J. M. TURNBULL, DIP.FOR.
Hon. Secretary-Treasurer: D. R. DE WET, B.SC., L.I.K.B.

Executive Committee:

J. D. KEET, DIP.FOR., M.SC. (HON.), (*Chairman*)
I. J. CRAIB, M.F., PH.D.
H. A. LORENTZ, LL.D.
PROFESSOR JOHN F. V. PHILLIPS, D.SC., F.R.S.E., F.L.S.
J. M. TURNBULL, DIP.FOR. (*Hon. Editor*)
D. R. DE WET, B.SC., L.I.K.B.

REDAKSIE-KOMITEE.

J. M. TURNBULL, DIP.FOR. —*Voorsitter.*

I. J. CRAIB, M.F., PH.D.

J. D. KEET, M.A. (ERE.) (*Ex officio.*)

PROFESSOR E. J. NEETHLING, B.A., M.F.

A. J. O'CONNOR, DIP.FOR.

PROFESSOR JOHN PHILLIPS, D.Sc., F.R.S.E., F.L.S.

Artikels oor alle aspekte van bosbou sal deur die Redaksie-Komitee in oorweging geneem word, en moet aan die Redakteur, ,,Die Tydskrif van die Suid-Afrikaanse Bosbouvereniging,'' Posbus 727, Pretoria, gerig word. Artikels van meer as 1,000 woorde moet van 'n opsomming waarvan kopiereg nie voorbehou is nie, van nie meer as vyf persent van die lengte van die artikel self vergesel word. Twaalf herdrukke van elke artikel sal kosteloos aan die skrywer daarvan verskaf word. Mits hulle bestel word voor die einde van die maand voorafgaande die van uitgawe, kan herdrukke bo hierdie hoeveelheid teen die volgende pryse vir eenhede van vier teksblaaie verkry word :—

100	*kopies*	*£0 16 6*
250	*,,*	*£1 5 6*
500	*,,*	*£2 0 6*
1,000	*,,*	*£3 10 6*

Onvolledige eenhede sal teen dieselfde prys as volledige eenhede gereken word. Gedrukte omslae, bestel belyktydig met die herdrukke, sal voorsien word teen 21/6 per 100, en 2/- per elke 50 bo die eerste 100. Illustrasies ekstra.

Kontribusies sal gepubliseer word in die taal waarin hulle ingestuur word. Opsommings mag in enige of beide amptelike tale ingedien word.

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of opinies van skrywers nie.

Lesers word versoek om die Vereniging se adverteerders waar gerieflik, in aanmerking te neem.

EDITORIAL COMMITTEE.

J. M. TURNBULL, DIP.FOR.—*Chairman.*

I. J. CRAIB, M.F. PH.D.

J. D. KEET, M.A. (HON.) (*Ex officio.*)

PROFESSOR E. J. NEETHLING, B.A., M.F.

A. J. O'CONNOR, DIP.FOR.

PROFESSOR JOHN PHILLIPS, D.Sc., F.R.S.E., F.L.S.

Contributions on any aspects of forestry or allied subjects will be considered by the Editorial Committee, and should be addressed to the Editor, The Journal of the South African Forestry Association, P.O. Box 727, Pretoria. Articles in excess of 1,000 words should be accompanied by uncopyrighted summaries, not exceeding five per cent. of length of originals. Twelve reprints of each article will be furnished to its author, free. Reprints beyond that number may be obtained, if ordered before the end of the month preceding that of issue, at the following rates per unit of four text pages :—

100	*copies*	*£0 16 6*
250	*,,*	*£1 5 6*
500	*,,*	*£2 0 6*
1,000	*,,*	*£3 10 6*

Incomplete units will be charged as for complete units. Printed covers ordered at same time as the text will be provided at 21/6 per 100, and 2/- for every 50 in excess thereof. Illustrations extra by arrangement.

Articles will be published in the language in which they are submitted. Summaries may be submitted in either or both official languages.

The Association does not hold itself responsible for statements or views expressed by authors.

Readers are urged to consider the Association's advertisers as occasion may arise.

INHOUD—CONTENTS

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of menings wat deur skrywers uitgespreek mag word nie. Met uitsondering van skrywers se opsomming, word kopiereg van alle artikels voorbehou.

The Association does not hold itself responsible for statements or views expressed by authors. With the exception of authors' summaries copyright of all articles is reserved.

	Page / Bladsy
Van die Redaksie—Editorial Notes and Comments	1
The Late Mr. H. A. Read.	
Unwelcome Visitors.	
Amptelike Taalgebruik.	
Roll of Honour.	
The Establishment and Maintenance of Freshwater Fish in South Africa, *by D. Hey, B.Sc.* Part III: Stocking Dams and Reservoirs. Part IV: The Economic Importance of Inland Fisheries. Summary	4
Notes on the Sylviculture of the Indigenous Forests, *by F. S. Laughton, B.Sc.*	24
Tree-Planting for Commercial Purposes, *by N. L. King, Dip.For.*	37
Depletion of Ground-Water Flow in Jonkershoek Streams, *by C. L. Wicht, B.Sc., B.A., Dr.Ing.*	50
Rodent Damage in Plantations and its Prevention, *by D. H. S. Davis, B.A.*	64
Timber Seasoning in South Africa, *by M. H. Scott, B.Sc.*	70
Grading and Sampling of Wattle Bark, *by A. J. Taylor, M.Sc., A.I.C.*	103
A Preliminary Investigation into the Causes of Torsion in Pine Stems, *by John M. Turnbull, Dip.For.*	112
Korrespondensie—Correspondence	118
The Value of an Immature Plantation.	
Taalfoute.	
Reviews	123
Forests and Erosion.	
Publications Received	125

ERRATA

P.1: For " 1832 " read " 1892."

Facing P.30, Fig. 1, caption: For " *Langni* " read " *Langeni.*"



HERBERT ALFRED READ, F.S.A.A.

VICE-CHAIRMAN,

THE SOUTH AFRICAN FORESTRY ASSOCIATION,

1938-1942.

OBIIT 8 JANUARY, 1942.

DIE TYDSKRIF VAN DIE
SUID-AFRIKAANSE BOSBOUVERENIGING
No. 8. APRIL, 1942.

THE JOURNAL OF THE
SOUTH AFRICAN FORESTRY ASSOCIATION
No. 8. APRIL, 1942.

VAN DIE REDAKSIE.
EDITORIAL NOTES AND COMMENTS

The Late Mr. H. A. Read.

With the passing on the 8th of January at his home at Parktown of Mr. Herbert Alfred Read, the Association loses one of its most esteemed officials. Mr. Read was born in London in 1873 and came to South Africa in 1832 to assume a commercial post at East London. Three years later he came to the Rand and after a short period of service with the Johannesburg Consolidated Investment Company was appointed sub-accountant to the Rand Mines, Limited. Joining the Exchange Yard, Limited, as Secretary in 1901, he eventually became Managing Director, a post which he occupied for many years up to his death.

Although not a professional forester, the enthusiasm for forestry and forest economics acquired by Mr. Read during a long and controlling association with one of the largest tree-growing and timber-using concerns in the Union won for his opinion on all such matters a measure of respect that is seldom accorded by the academically trained forester outside his immediate circle. His achievements and influence in this direction were considerable. The magnificent estate of his Company at Rooikoppies, near Tzaneen, and his share in the wide extension of afforestation by private enterprise that has occurred in the Eastern Transvaal during the last twenty years will constitute enduring monuments to his efficiency and enthusiasm. He may be regarded as one of the pioneers in the commercial cultivation of saligna in the Transvaal. His interest in the possibilities of the species was not confined to its value to the mining industry. His foresight was greater than that, and he was a stout advocate of the part apportionment of growing stock for the development of saw timber for furniture and other appropriate purposes for which the normal short rotation crops of the species are unsuited. The latest phase of his interest in saligna concerned its use in the reclamation

of fatigued agricultural soils. Up to the time of his last illness he was conducting in collaboration with Dr. Merensky a series of experiments at Tzaneen for the purpose of demonstrating this, and a preliminary report on them from his pen will be found in these pages. Mr. Read's early recognition of the advantages of preserving mining timbers, giving rise to the installation in Johannesburg of the largest timber preservative yard in the country, and his share in initiation of the Transvaal Chamber of Mines' closely associated Research Laboratory, to the investigations carried out by which the whole Reef is enormously indebted, establish his name as an undoubted benefactor to South Africa's foremost industry.

Mr. Read had been Vice-Chairman of our Association since its inception in 1938. His zeal in increasing its membership and in securing donations to its funds was unbounded. His punctiliousness in attendance at general and Committee meetings, involving a 75 mile trip on each occasion, was frustrated only by extreme circumstances. An excellent Chairman, the discipline he brought to the conduct of meetings was tempered with a geniality and equity that will long and pleasantly persist in the memory of his fellow officers. His contributions to our pages have been few and brief, but always very much to the point, and penned with a grace that faithfully reflects his own personal charm.

Amongst other organised forestry movements with which he was associated, Mr. Read was President of the Tzaneen Saligna Growers' Association and, from 1927 to 1935, Local Honorary Secretary to the Empire Forestry Association.

Uwelcome Visitors.

Apprehension has arisen in official quarters from the fact that recent shipments of softwood timber unloaded at South African ports have been found to be infested with live bark beetles of various species. The wood concerned arrives mostly in the form of dunnage used to stabilize cargoes in the holds of vessels while in transit, but timber supplied against indents is also affected. The affected material consists of waney boards and baulks from which the bark, under which the pests harbour, has not been stripped before shipment. The danger of the insects domiciling and propagating themselves in our coniferous forests in a manner similar to the snout beetle invasion of our eucalypt plantations in the past, cannot be contemplated with equanimity. Up to now coniferous plantations in South Africa have been remarkably free from bark beetles. It is hoped Government will avail itself of the wide powers invested in it under the new Forest and Veld Conservation Act to frame and enforce any regulation which might help in combatting this menace. The Government has no direct jurisdiction over shippers overseas, but no doubt measures can be devised which might provide legal support to indenters when dealing with future shipments containing unbarked wood, or with any cargo secured in holds by unbarked dunnage.

Amptelike Taalgebruik.

Twee korrespondente wys op sekere ernstige gebreke ten opsigte van spelling, sintaksis en woordeskat in offisiële kennisgewings wat in ons jongste uitgawe gepubliseer is. Ons is hierdie korrespondente dank verskuldig en ons kan ons lesers verseker dat die sorg wat tot dusver gedra

is om sulke foute te vermy in die vervolg verdubbel sal word. Een van hierdie korrespondente, wat in die verlede waardevolle dienste aan die Vereniging bewys het, spreek ontevredenheid uit oor die gebrek aan Afrikaanse artikels in die Tydskrif en gee aan die hand dat die Redakteur reëlings moet tref om hierdie leemte aan te vul. Dit is kwalik 'n funksie van die Redakteur, wie se optrede voorgeskryf word in die konstitusie van die Vereniging. 'n Wenk aan medewerkers ten opsigte van die taal waarin 'n artikel geskryf moet word sou nie alleen 'n ligte vorm van dwang wees nie, maar kan verder daartoe lei dat opmerkings en gedagtes aangebied word in 'n taal waarin medewerkers hulself nie op die beste manier kan uitdruk nie. Die enigste ander manier waarop die ewewig wat betref offisiële taalgebruik gereël kan word, indien dit werklik nodig is, sou wees om bydraes uit te soek op grond van die sogenaamde 50-50 basis. So 'n beleid is onuitvoerbaar, omdat dit sou lei tot die afkeuring van 'n groter persentasie artikels in die oorwegende taal, d.w.s. dit sou die onvermydelike gevolg hê dat waardevolle artikels wat in eersgenoemde opgestel is opgeoffer sal moet word ten gunste van artikels van laer gehalte in die ander taal geskryf.

Die huidige en enigste uitvoerbare redaksiebeleid is om bydraes streng volgens hulle meriete te beoordeel, afgesien van die taal waarin hulle geskryf is. Die doel van die Tydskrif is in die eerste plek om kennis te versprei, 'n taak wat op die beste manier verrig kan word deur publikasie van die leersaamste bydraes wat aangebied word in die taal wat die skrywers self die geskikste vind vir duidelike en maklik verstaanbare weergawe van hulle sienswyse.

Roll of Honour.

News of the death on active service of Mr. D. C. Prior in Libya early this year was received with deep regret by the many fellow members of the Association to whom he was known. Mr. Prior served as a young man in the last war with the South African Artillery, and re-enlisted in the same arm shortly after the outbreak of the present one. He was an able and trusted forester in the Union Public Service, with over 27 years' service to his credit, the last 10 of which were spent at Coetzeestroom, in the Eastern Transvaal, where his efficiency and pleasing disposition will be greatly missed by all who came into social or official contact with him.

THE ESTABLISHMENT AND MAINTENANCE OF FRESHWATER FISH IN SOUTH AFRICA

By D. HEY

(Assistant Curator, Jonkershoek Trout Hatchery.)

III. STOCKING DAMS AND RESERVOIRS

THE development of South African inland waters is, to a large extent, in the hands of the individual landowner. Few people realise that it is possible to develop water in the same manner as land is cultivated. In this way thousands of acres of water which are lying idle to-day could be utilized to produce some species of freshwater fish. Whether this be done for economic or sporting reasons, the possibilities are enormous. Fish is a healthy and nutritious foodstuff and once inland waters are developed to produce this commodity they become a natural food reserve which may be utilized to the full in times of stress.

Suitable Species

Ecological conditions in dams and reservoirs differ markedly from those obtaining in rivers and streams. Those species of fish adapted to live in running water are not suitable for stocking dams and reservoirs. The latter fishes are the non-migratory, so-called warm water forms such as largemouth bass, bluegill sunfish, perch, carp and tench, each of which, together with the valuable forage species, the gambusia top minnow, are here fully described.

American Largemouth Black Bass.

The American largemouth black bass *(Huro salmoides)* is a spiny rayed fish found exclusively in freshwater, belonging to the family *Centra-archidæ*, order *Actinopterygii*. The following characteristics distinguish it from the smallmouth species: the maxillary bone extends beyond a median line through the eye; the scales of the cheek are nearly as large as those of the body, there being 10 rows in a line between the operculum and the eye; the dorsal fin is distinctly notched, there being a more acute angle between the hard and soft fin rays than in the smallmouth species. The largemouth is stockier in form and darker in colour than the smallmouth, with the longitudinal marking more pronounced. Its maximum weight is authentically stated to be 20-30 lbs., though in most localities it does not exceed 6 and the average is probably not more than 3 lbs. (9). The African record to date is one of 7 lbs. 9 ozs. taken on a fly in the Matopo Dam, Bulawayo, but it is likely that much larger specimens will be caught.

The largemouth bass is indigenous to America, ranging from Canada to the Gulf of Mexico and from the Atlantic Coast to the Rocky Mountains. Forty-five fingerlings were introduced into South Africa in February, 1928, and they spawned for the first time at the Jonkers-

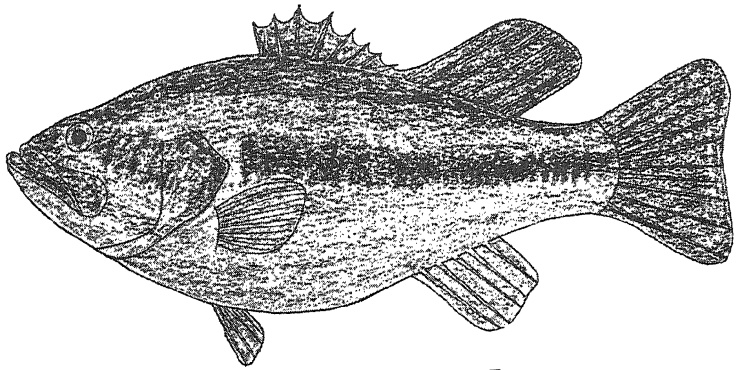
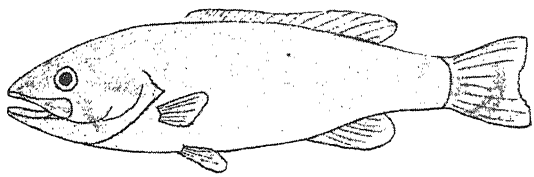
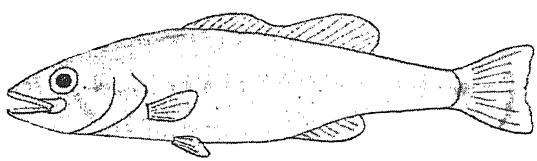


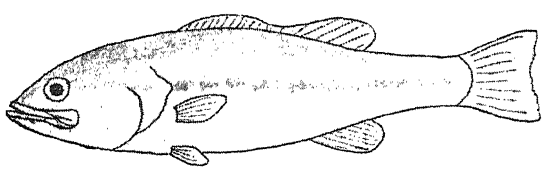
FIG. 1.—Largemouth Bass.



A.



B.



C.

FIG. 2.—Diagram showing the differences between the three species of Bass fry.

A. Smallmouth Bass.
B. Spotted Bass.
C. Largemouth Bass.

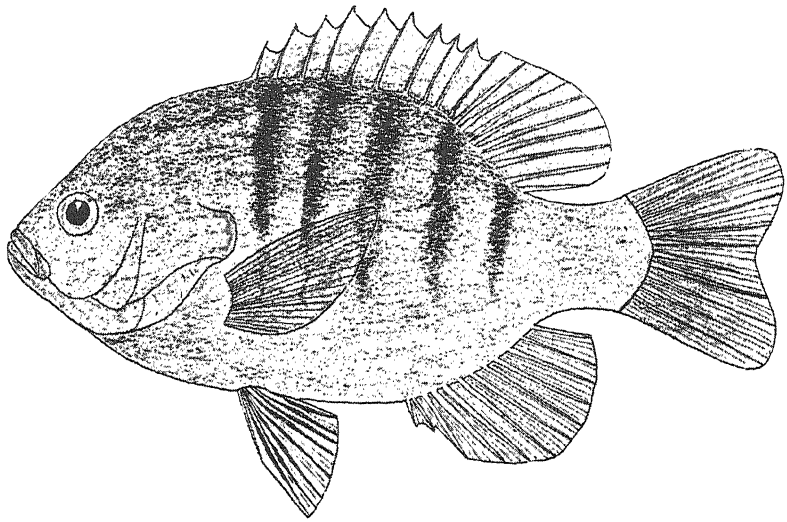


FIG. 3.—Bluegill Sunfish.

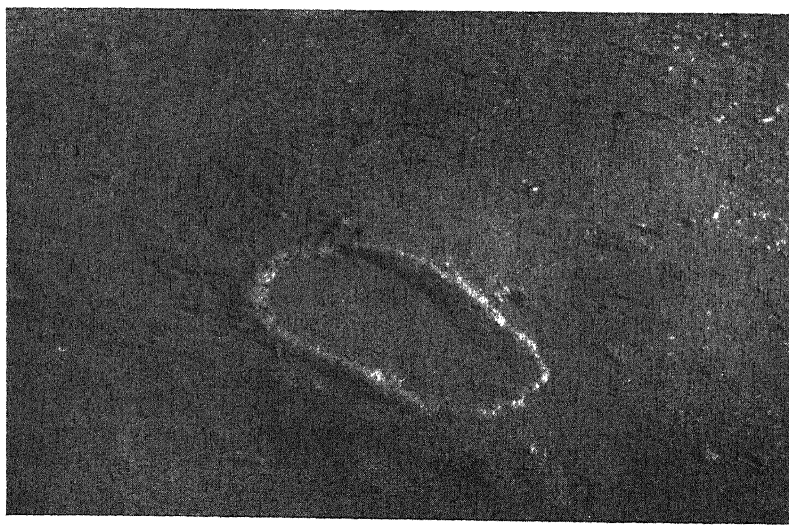


FIG. 4.—Bluegill Sunfish nest approximately 2 ft. 6 in. by 1 ft. wide.

hoek Hatchery in November, 1929. Since then they have been distributed throughout Southern Africa.

The habits of the largemouth bass are such as to make it an ideal pondfish. It is especially suited to localities where the water is too warm and muddy for the smallmouth species and other game fishes that require clearer and cooler water. It tolerates occasional water temperatures as high as 90° F. The breeding habits are very similar to those of the smallmouth bass described in Part II, differing only in details. They nest on a variety of materials such as stones, gravel, among fibrous roots, or on a hard pond bottom, but in all cases the nest is assiduously cleaned and fanned free from mud and silt. Where the floor of the dam consists of soft, deep mud, however, this is by no means an easy task, and in some cases the fish are unable to reach the hard bottom. Under these conditions they do not spawn. In order to enable them to do so, it is necessary to place patches of gravel, approximately three feet in diameter, at intervals round the margin of the dam in water 1-1½ ft. deep. If the mud floor is so soft that the gravel sinks away, it should be placed in shallow wooden trays.

Largemouth bass normally nest in spring when the water temperature rises to 65° F. The nest is the property of a single male, but may be spawned in by more than one female. The male guards it against all invaders and during this period does not feed. With regard to the fecundity of bass, Culler (4) states " the ovaries taken from a 2 lb. 12 oz. largemouth bass showed a count of approximately 79,000 eggs." Under normal conditions a bass will spawn when a year old.

The eggs, which are pale yellow in colour, are similar to those of the smallmouth, but smaller, there being 16-17 to the linear inch. At a temperature of 65° F. hatching takes place within 10-15 days, whereas at a temperature of 80° F. within only 5 days (15). Bass fry remain on the nest until the yolk sac has been absorbed, after which they school, frequenting the shallower water which is rich in microscopic animal life. They may remain in schools until over an inch in length, a characteristic distinguishing them from the smallmouth species, the fry of which scatter when only ½" in length. At this stage the largemouth fry are of a yellowish transparent colour with a very pronounced black stripe down the body. They feed on *Entomostraca* but as they grow, seek larger and larger food items, feeding on smaller fish when less than two inches long. At this stage, heavy losses of fry are likely to occur as a result of cannibalism, in ponds with insufficient natural food. Once cannibalism has started, by virtue of a certain size advantage of predator over prey, the cannibals continue to grow much more rapidly than the non-cannibals, resulting in a continual increase in size dispersal throughout the summer. Where there is an abundance of food, losses of fry from this source are much smaller. Furthermore, cannibalism is less frequent among the rapidly growing populations of bass than among the slower.

Production figures under intensive conditions in America illustrate very clearly the possibilities of the largemouth bass as an economic fish. In the nursery ponds at Fairport, Iowa, where the growing season is only of 4 months duration, 11,550 three-inch fingerlings were produced per acre (16). In fertilised ponds and under natural conditions production is about 3,900 fingerlings per acre, which is approximately what should be expected from the average farm dam.

Since bass are extremely predaceous they should be propagated in dams exceeding 3 acres in extent, in which there is an ample natural food supply. They should not be placed alone in smaller dams where they soon exhaust the food supply, resulting in a stunted population of starving bass. In such dams forage fish must be used to augment the food supply. Swingle and Smith (13) report such remarkable success by using bluegill sunfish in combination with bass that they have found it possible to cultivate them in dams of less than an acre. In South Africa, most notably in Paardevlei, Somerset West, tench have proved excellent forage for bass.

When stocking with largemouth bass the old method was to allow a sex ratio of 1-1 (with a slight predominance of females to prevent fighting among the males), using about 60 fish per acre. According to the most modern American authorities, 4 to 5 pairs of fish per acre are quite sufficient.

Largemouth bass are valuable table and sporting fish. The flesh is flaky and free from bones, and although it has a slightly peculiar flavour, it is equal in quality to trout. In addition bass are very game fighters and can be taken on natural or artificial baits. Those up to 2 lbs. in weight are easily caught and are thus ideally suited to the fisherman of indifferent ability, whereas the larger specimens will test the skill of the most experienced fisherman.

Bluegill Sunfish.

Bluegill sunfish *(Helioperca macrochira* syn. *Lepomis macrochira)* belong to the sunfish family *Centra-archidæ* which is native to the fresh waters of N. America. Their nearest relatives are the perches *(Percidæ),* from whom they are separated by anatomical details only. The body is short and deep, a form characteristic of many marine fishes, the length, exclusive of tail, being about twice the depth of the body. The spiny and soft portions of the dorsal fin are united and not notched, the dorsal spines are high, and there is a large black spot at the rear of the soft dorsal. The anal fin has three or more spines at its front end and the pelvics have each one spine and five soft rays. The operculum ends as two flat points, the outer of which is enlarged as a black opercular flap hiding the inner. The colour is olive with a purplish lustre and the back is banded. They are small fish attaining a maximum weight of 1½ lbs. in their native waters, but it seems possible that they will grow larger in South Africa. Dr. I. Craib reports that bluegills attained the remarkable weight of 12 ozs. within twelve months of stocking as fingerlings in a dam on the Zoutpansberg.

The breeding habits are similar to those of the basses, the nest being the property of a single male. Bluegills nest on the hard bottom of a pond and make considerable excavations in comparison to their their size, as illustrated in Figure 4. They are extremely prolific; a bluegill sunfish of two years, weighing 6½ ozs., produced 32,950 eggs (3).

The breeding season is more variable and extended than that of bass, and nests may be found throughout the warmer months of the year. It is difficult to distinguish the sexes by external differences except for a short period prior to the breeding season. At this time the abdomen of the female is more distended than that of the male, whereas the male is more brilliantly coloured.

Bluegill sunfish are likely to prove a great economic asset to South Africa, for, besides being useful forage fish, as already indicated, they are valuable sporting and edible fish. They take artificial lures freely, and, in proportion to their size, possess greater fighting qualities than most freshwater fish. Although small, they are highly esteemed as table fish, the flesh being sweet and free from bones.

The bluegill is probably the most desirable of all the sunfishes for pondculture. It will adapt itself to most environments and is especially suited to small dams as it is an omniverous feeder. Owing to its small jaws, it is able to feed on animal life which is too small for the larger game fishes. Furthermore, it will feed to a certain extent on vegetation. These fishes are extremely prolific, however, and it is essential that the pond be properly controlled either by heavy fishing or by netting. The large bluegills will not eat many of their own young with the result that the pond soon becomes over-stocked, the food supply inadequate and growth stops. The older fish soon lose weight and a high mortality results. In order to obtain the maximum yield per acre, therefore, it is necessary to place the correct number of carnivorous fish in ponds stocked with bluegills. Largemouth bass, especially, reduce both the young bluegills and the young bass to approximately the correct number for rapid growth. They have been used successfully in combination with bluegills in dams as small as ½ acre (13). The bluegills should not be placed in the dam two or three years in advance of the bass. Where this is done the pond soon becomes overcrowded with stunted bluegills which prevent the bass from spawning successfully. The bass and bluegills should be placed in the dam together, or at the most the bluegills may be introduced a year before the bass.

Perch.

The yellow or European perch *(Perca fluviatilis)* belongs to the family *Percidæ*. It is indigenous to Europe, but two closely allied species occur in north eastern America and Turkistan respectively. The body is somewhat compressed and moderately elongated, tapering posteriorly, with the back more or less humped between the occiput and the dorsal fin. The upper part of the head is smooth and scaleless, while the whole body is covered with small rough scales. The operculum ends in a characteristically long spine. There are two dorsal fins, a longer anterior one formed of from 14 to 16 spines, and a shorter posterior one with two spines and 13 to 16 soft rays. The anal fin has two spines and 8 to 10 branched rays. The cadal is emarginate and the pelvic fins consist of a strong spine and five branched rays (14).

The colouration of the perch varies somewhat according to locality, age, sex, and season. The colour of the back and sides is greenish yellow, whilst the belly is white. On the side there are five or more dark vertical bars which are sometimes bifurcated above. The dorsal fin is greyish black while the ventral fins are reddish (14). Sometimes the bars are inconspicuous and the whole fish appears almost uniformly dark green, whereas at others the deep black bars are in striking contrast to the pale olive background.

In their natural habitat perch are very hardy and inhabit slow-flowing rivers, deep lakes, and ponds, often living in brackish waters where

they seem to thrive and grow abnormally large. They do not usually attain a length of more than 18″ with a weight of 4 to 5 lbs. They were introduced into South Africa in 1914 but have not proved too successful. This may be partly due to the fact that they have not been given a fair trial. Only two cases are on record of successful stocking in South Africa. The first is in Paardevlei, Somerset West, where good catches of perch are made, the largest to date being one of 5 lbs. A phenomenal case is on record from the Somerset East district where the netting of a dam stocked with perch yielded 80 fish over 4 lbs. in weight, the largest being one of 5½ lbs.

In early spring as soon as the temperature of the water begins to rise the perch shoal and spawn in the shallow gravel portions of the river or among the reeds at the sides of the dam. The eggs are of a yellowish white transparent colour and are enclosed in a ribbon-like, elongated mass. The length of the string varies from 2 to 7 ft., depending upon the size of the fish. It is recorded that a yellow perch of 24 ozs. deposited a string 88″ long, 4″ wide at one end and 2″ wide at the other (6). Throughout the entire length of the string there is a cavity, the walls of which are formed by the delicate membrane surrounding the eggs. Small apertures occur at regular intervals, their purpose apparently being to admit the free circulation of water to facilitate incubation. Upon deposition the eggs are in loose, globular form, but after being fertilised and water-hardened, the mass becomes many times larger than the parent fish. The incubation period at a mean water temperature of 47° F. is 27 days, and the yolk sac is absorbed in a further 5 days (6). When hatched perch fry are very delicate and practically transparent, resembling splinters of glass. They begin feeding on *infusoria*, gradually passing to larger food items.

Perch are bold and voracious and in the summer months hunt in shoals for their food which consists of worms, insect larvæ, small fish, etc. They are good game fish, fighting well on light tackle, but their boldness renders them "easy meat" for the most inexperienced fisherman. A peculiarity of perch is that once a shoal has been located a fish is caught each time the lure is thrown into the water. Should one be hooked and lost, however, the shoal will immediately make off and no guile on the angler's part will induce another to take the lure.

The food qualities of the perch equal most other freshwater fish. The flesh is white, firm and well-flavoured, but fish caught in clear waters are superior to those from dams. The flesh of all freshwater fish, however, varies with environment. No game fish can attain the highest degree of excellence as to either food or game qualities in warm, sluggish, turbid waters. Taken from the clear cool waters of a deep lake or dam, the flesh of the yellow perch will compare favourably with that of any species of black bass.

As they are not as voracious as bass, perch can be used for stocking farm dams which are rather too small for the former species. They can also be used in combination with bluegills, but no data are available at present on their suitability for culture on a commercial scale. It is doubtful, however, whether they will surpass largemouth bass in this respect. In large dams perch can be used in combination with bass. They do not compete with the latter for food, but, on the contrary, young perch make up a considerable proportion of the food of the bass (5).

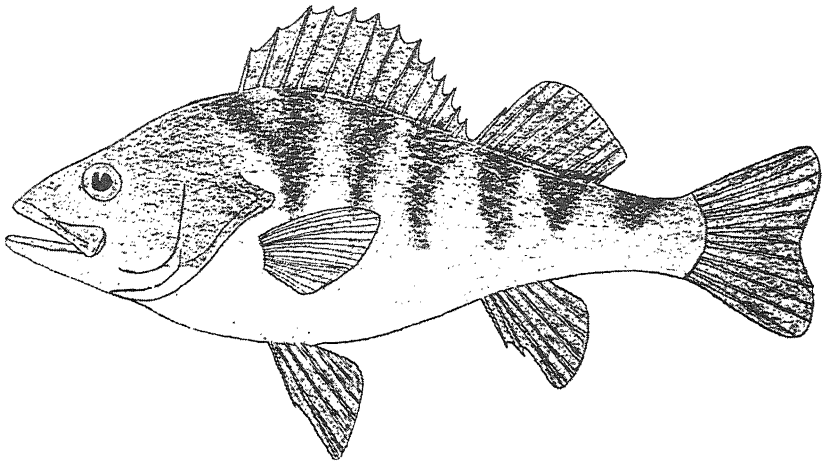


FIG. 5.—European Perch.

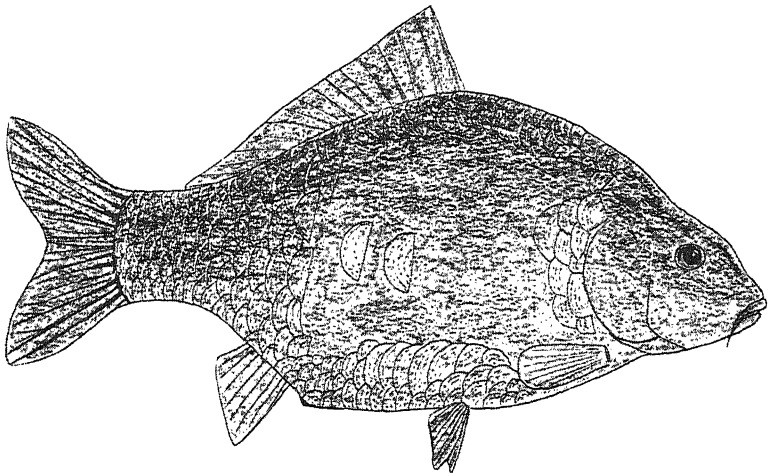


FIG. 6.—Mirror Carp.

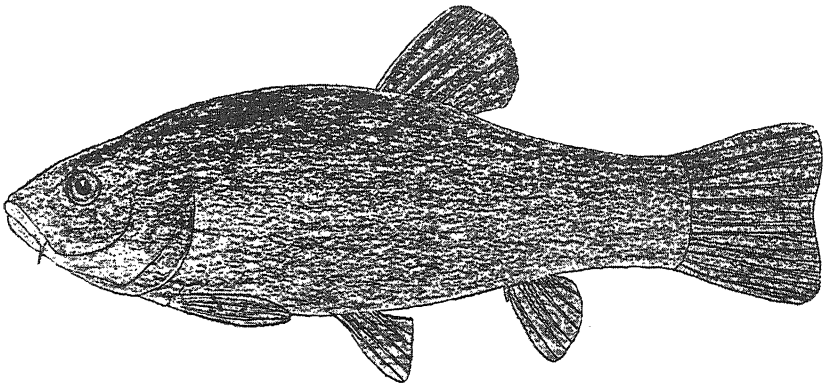
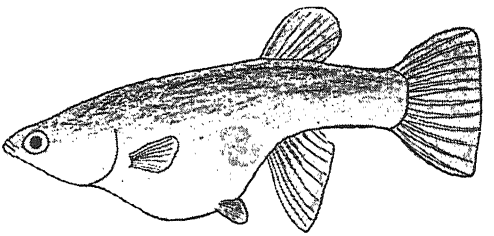
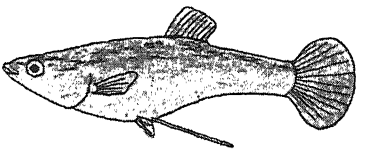


FIG. 7.—Tench.



Female



Male

FIG. 8.—Gambusia Top Minnows.

Carp.

There are decidedly conflicting ideas throughout the world with regard to the economic value of carp *(Cyprinus carpio)*. They were introduced into the Cape Colony in 1897, as a food fish (8). Unfortunately, no pains were taken to culture them correctly and they were placed in numerous small farm dams, where they multiplied prolifically. Under such conditions they were of little sporting or food value and were placed on the Black List by the Cape Provincial Administration. It is now illegal to transfer them from one dam to another. Despite this, carp continue to spread to potentially more valuable waters, and it is unlikely that legislation, no matter how severe, will ever produce the desired results. This legislation might prove more effective if the reasons for prohibiting the uncontrolled distribution of carp were explained to the public.

According to the U.S. Bureau of Fisheries, it is the most valuable and widely distributed fish in the freshwaters of the United States (2). In Europe it has for centuries been cultivated on a large scale as food. In the olden days carp ponds were to be seen in monastries all over Europe.

Though classified as coarse fish, carp, if properly cooked, are good eating. Impartial scientific investigation has shown that carp is of high food value, is acceptable and palatable when properly cooked, is freest from parasites, is easily handled and shipped, and is one of the most prolific fish found in America (1).

Shortly after their introduction into South Africa they surpassed all expectations of hardiness, rapid growth and prolificacy. Prejudice soon grew, however, on account of their muddy taste, numerous bones and poor sporting qualities. Another objectionable feature of carp is that they discolour the water as a result of their method of feeding. They take in and then eject mouthfuls of mud from which they extract nutriment in the form of decomposed vegetable matter. When present in large numbers they discolour the water so badly that in some cases stock will not drink it. Some farmers go so far as to say that in extreme cases the water becomes so foul that it cannot be used even for irrigation purposes. No data are available on this point.

The carp family *(Cyprinidæ)* belongs to the important order *Ostariophysi*, which includes a large proportion of the freshwater fishes of the world. All diverse types agree in the possession of a very peculiar appartus formed by the modification of four anterior vertebrae, some of the elements of which ossify to form a chain of little bones on each side, the Weberian ossicles, which connect the air bladder with the ear. The *Cyprinidæ* are probably richer in species than any other family of fishes, more than a thousand having been described from the lakes and rivers of Europe, Asia, Africa and America. The most characteristic feature of the family is the falciform lower pharyngeal bones, with two hard tooth-bearing plates attached to backwardly directed processes of the basal part of the skull. The form of these pharyngeal teeth, their number and arrangement in one, two or three series is of great importance in the distinction of genera and species. They are fishes with a naked head and a scaly body, having all or most of the fin rays jointed and flexible. The pectoral fins are abdominal in position and there is no adipose fin. The mouth is toothless and more or less protractile. The three most

important forms of carp are the scale carp, having regular concentrically arranged scales, the mirror carp, so named because of 3 or 4 rows of extraordinarily large scales running along each side of the body, and the leather carp, having only a few scales on its back and possessing a thick soft velvety skin.

Carp are voracious and omnivorous as may be judged from the great size which they reach. They have been known to grow to a foot in length in 9 to 10 months and it is recorded that a carp in the state of New Jersey attained a weight of 30 lbs. in 3 years (Prince, 11). This writer also states, " The carp tribe stand in the fish family much as the hog does among quadrupeds. Confine the latter in a pen and steadily respond to its cravings of appetite and it will increase in flesh, and multiply in size to an extent which will reward the care of his owner. Similar treatment applied to the carp, changed only to suit the different environment in which he lives, will make him a productive and profitable fish."

Experiments have proved that few kinds of fish are so tenacious of life as the carp. They can live for a long time out of water and can be sent alive for considerable distances packed in damp moss. In fact, they often breathe atmospheric air even under normal conditions in warm weather.

The carp is not cannibalistic in its habits and will not devour its young to any great extent, but is very partial to its own eggs. Under proper conditions carp will spawn when two years old, being then 16″ to 18″ long (1). Pre-spawning activity begins when the temperature of the water has risen above 60° F., the males driving the females. They spawn on aquatic vegetation, each female spawning a number of times at intervals of a few weeks. The number of eggs produced by a female carp during an entire season will vary from 300,000 to 700,000 according to her size, but not more than 400 to 500 are deposited at one time. After the eggs have been laid they are left to their own devices. When cultured in small dams carp can be fed on a mush made of low-grade flour, or other cereals. They may also be given cooked vegetables such as cabbage, potatoes, corn or turnips.

In waters abounding in trout and other game fish the inferior species such as carp are a curse and it would be a thousand pities if they were introduced. They breed so fast that they soon crowd out these species. There are inferior waters, however, unsuitable for other edible species, which could be used for the culture of carp. Under such conditions they are of decided economic value as an edible fish, being prolific and easily cultured on very coarse food. Unlike other freshwater fish such as trout, perch, bass, etc., they are not essentially palatable but require to be transferred after capture to clear running water to rid them of their characteristic muddy flavour. If the fish are fed when so held, their food should consist of clean vegetables, meat or cereal, such as shelled corn or wheat, these grains being especially desirable as they give a firm, hard texture to the flesh. The muddy flavour can also be disguised by seasoning with wines and other spices when necessary. Carp are of little sporting value as they are wily and difficult to catch.

Tench.

Tench *(Tinca vulgaris)* were imported into South Africa in 1910 to replace carp. They are European *Cyprinoids,* possessing all the

advantages of carp without their attendant disadvantages. In form they are moderately deep and stout and may attain a weight of 8 lbs. The head is broad, the snout blunt and the mouth terminal and oblique, with a short barbel on each side near the corner. The scales are small, numbering 100 to 120 in the lateral line. The dorsal and anal fins are rounded; the former originates above the base of the pelvics and has 8 or 9 branched rays, while the latter has from 6 to 8. The colouration varies from greenish yellow to greenish black (14).

This fish is pre-eminently an inhabitant of still waters but will also thrive in slow-flowing rivers which are not subject to violent floods. They are suitable for stocking weedy farm dams which are too small for the predaceous game fishes. In this way water may be utilised for the production of valuable food which might otherwise lie idle. The tench is a quiet, indolent fish lying on the bottom of the pond, or on hot, calm days among the weeds on the surface. Like carp, tench can live for some time out of water and they have been known to live buried in the mud bottom of a pond which had dried up during a hot summer (14). They breed in early summer when the males may be distinguished by the greatly enlarged outer ray of the pelvic fin. The eggs are very small and numerous and are deposited on the vegetation in shallow water. It is interesting to note that it has been found possible to strip tench and to milt the eggs artificially as is the practice with trout (12).

Tench are of economic and, to a certain extent, of sporting value. Their most important role, however, is that of a forage fish. Being vegetarians, they do not compete with the game fish for food and their young are ideal forage for the latter. Furthermore, they are extremely prolific, and will attain such a size that the stock cannot be destroyed by the cannibal game fishes.

They may also be cultured in small weedy ponds especially for table purposes. The flesh is edible but varies a great deal in quality, depending on the water from which the fish are taken. The chief disadvantage of tench as a table fish lies in its large number of fine bones. Any muddy flavour may be removed by placing the fish in clear running water for a few days, or by scalding. In the Middle Ages this fish was much appreciated as an article of diet and was cultured on a very large scale by the monks in their stew ponds.

Gambusia Top-Minnows.

These small fish, *Gambusia affinis,* belonging to the family *Pœciliidœ,* have no sporting or table value but are of importance in the control of mosquitoes, and as forage for the larger game species. The generic name *Gambusia* is derived from the name "gambusina," commonly used in Cuba, which means small or of no importance. They are indigenous to Central America and the West Indies, but have been distributed throughout the world to aid man in his fight against mosquito-borne tropical diseases such as yellow fever. While of no direct commercial value, this species has a great economic worth, for it feeds to a large extent on mosquito larvæ. They possess certain characteristics which render them superior to other fishes as mosquito destroyers. As suggested by their name "top minnows," they feed on the surface of the water where mosquito larvæ are found. Being of small size they can make their way into extremely shallow water and can thus be bred

in small ponds. The young are born in an advanced stage of development and are not subject to the dangers which beset the young of oviparous fish. They are very hardy, tolerating a temperature range from 40° to 100° F. and will even live in brackish water. It is mainly through the introduction of these fish that Panama has been rendered habitable.

They are a pale greyish-green shading to white on the belly with a metallic reflection. The dorsal and caudal fins are usually marked with rows of tiny black dots. The female is larger than the male, being about 2 inches long whereas the latter seldom exceeds 1 inch, and is further recognised by the fact that the anal fin is modified to form a gonopodium or intromittent organ. The young are born alive and a pregnant female can readily be recognised by the metallic blue gravid spot near the vent.

They can be placed in any type of water. In small ornamental ponds they control the mosquito larvæ and in large dams they inhabit the shallow areas, multiplying and serving as forage for the game species.

The Management of Dams

Stocking.

The manner in which a pond is stocked will affect its productivity for many years. If properly stocked, a pond should furnish sizeable fish within two years or less; otherwise it may require 5 to 10 years.

Whatever the species of fish used, the basic principles of stocking remain the same. In all cases the fish introduced should be as large as possible in order to hold their own against numerous predators. If large stock fish are not obtainable, it is advisable to grow the fry out in a small dam before placing them in the large one. Fry of all the species described can be obtained from the Jonkershoek Trout Hatchery, Stellenbosch. The methods of transportation and liberation have been fully described on page 27, Part 2 of this series.

When stocking a new water, only fish which are known to be suitable should be used. Hasty stocking with inferior species may render the water unsuitable for better economic and game fishes. All species which are suitable for culture in dams and reservoirs are non-migratory in their habits. The largemouth bass, bluegill sunfish and tench are especially hardy, thriving in waters ranging from 60° to 90° F. with occasional surface temperatures of 95° F. Another point to be remembered is that where a species of fish is established and proving satisfactory, the introduction of a foreign species may upset the balance completely. All animals are so integrally bound up in their relations with one another that one can never foretell the results when a new species is introduced. No two kinds of animal life are in identical relationship with their environment. Furthermore, the behaviour of each species will vary from time to time and place to place in accordance with changes in the environment.

The number of fish which should be introduced into a dam depends upon the weight of fish the dam can support. This is determined by the size of the dam and the fertility of the soil. In Alabama, according to Swingle and Smith (13), unfertilised ponds can support on an average about 150 pounds of fish per acre of water, whereas fertilised ponds produce 500 to 600 pounds. What the potentialities of our South African waters are remains to be seen, but it is unlikely that they will prove

lower than this. In all ponds and dams, however, conditions vary from year to year. This causes a variation in the number of fish present, but over a period of years there are just as many fish present as can find food enough to support them. If the fish increase unduly, they eat too many of the animals on which they live, causing a scarcity of food, which in turn brings about a reduction in the number of fish. Productivity can be increased considerably in all waters by stocking with species of diverse feeding habits. A single species does not utilise the available food to the fullest extent when placed alone in a dam, and is therefore no criterion of the fertility of that water.

After a pond has been stocked, it should not require the addition of more hatchery fish. Overstocking results in overcrowding as the fish become larger. Competition for food becomes too keen and will result in uneven growth and finally cannibalism. Proper stocking ensures an abundance of food in ponds properly fertilised, which, in turn, will ensure even growth of the fish. Poor fishing in most older dams is not due to lack of sufficient brood stock. It is usually caused by a lack of sufficient fertility to produce the necessary food, by the absence of carnivorous fish or, occasionally, by the presence of a considerable number of very large fish, which upset the balance of the pond.

It is most important that once a pond has been adequately stocked and the fish have established themselves, their number should be controlled by netting or fishing. Netting or fishing does not necessarily reduce the permanent population, provided that more fish are not removed than can be added to the population each year by the brood stock. If a certain number of fish are removed from a body of water it merely makes it possible for a larger proportion to grow to maturity.

Fertilisation.

As indicated in Part I, the application of fertiliser constitutes the first step in the development of a food chain by encouraging the growth of tiny plants known collectively as *Algæ*. These are so important as food for higher organisms that if they ceased to exist there could be no aquatic life. The elements used most extensively in plant growth are nitrogen, phosphorous, potassium, sulphur, calcium, magnesium and iron, and it is essential to have a knowledge of the nature of the soil prior to fertilisation in order that the correct fertiliser may be used.

Of the numerous fertilisers advocated, a 3 to 1 mixture of sheep manure and superphosphates (16%), 500 lbs. per acre per annum, appears to be the most economical and satisfactory. The fertiliser should be applied in small quantities approximately every four weeks, or whenever the water loses its green or brown colour and becomes clear enough for the bottom to be seen in 3 ft. of water. Should an algal "bloom" (scum) develop on the surface of the water, fertilisation should be suspended for a time. A heavy water bloom may cause an oxygen deficiency due to the decaying microscopic algæ or as a result of the oxygen absorbed by them at night. Ponds having the least amount of overflow water require the least amount of fertiliser. In small ponds up to several acres in extent, the fertiliser is applied by a person walking along the edge and broadcasting it towards the deeper water. In larger dams it may be more economical to use a boat.

The yield of fishponds is adversely affected by so-called hard vegetation,

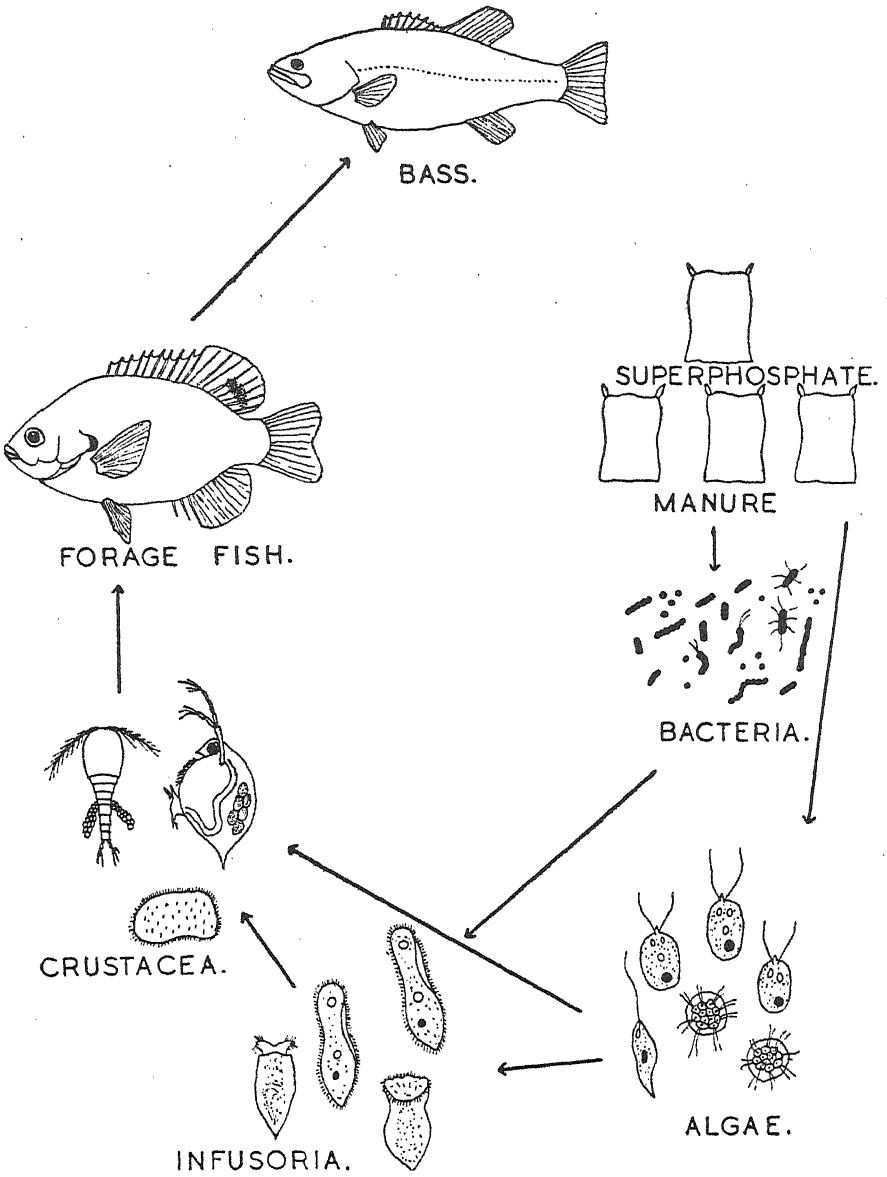


FIG. 9.—Diagrammatic food chain.

i.e., plant growth reaching above the surface of the water which does not die and decompose in one vegetation period (such as the reed or bullrush), yet extracts useful substances from the soil. The submerged vegetation, too, should not be allowed to increase to any excessive extent as it interferes with the complete utilisation of the fertilisers by the algæ,

which affects the productivity. The method of controlling this vegetation has been described in Part 1.

Forage.

The importance of an adequate food supply for fish cannot be over emphasised. Fish, just as terrestrial animals, require plants or other animals for food. Furthermore, just as a paddock of a certain size can carry only a certain number of sheep, so a dam can produce only a limited number of fish. The sole means of raising the productivity is by increasing the food supply.

Vegetarian fishes such as tench and carp can be cultured in the smallest ponds as a greater amount of vegetation can be produced per unit area than of animal food. Soft plants such as *Lagarosiphon, Nitella,* and *Cabomba* are the most suitable for this purpose and are easily cultivated.

Daphnia is the best of the animal foods for smaller fish on account of its ability to attain enormous numbers in a short time. Under optimum conditions each female produces eggs that develop without fertilisation (parthenogenetically) into other females so that all the individuals in a culture are the potential producers of other *Daphnia.* Two other types of individuals frequently occur, the winter-egg bearing females and males. Neither of these are desired in cultures planned for maximum numbers and when present they indicate that the culture has passed its peak of production. Winter or sexual eggs, usually one or two in number, are carried in a special modification of the external covering, the ephippium or saddle, on the back of the female *Daphnia.* Once fully developed, the females bearing them die, and they break loose from the parent body and float on the surface of the water. These eggs require the stimulus of freezing before they will hatch (10). Needham found that after the eggs had frozen and thawed eight times, the best hatch was obtained and also the shortest hatching period. Eggs frozen and thawed less than five times failed to hatch.

In nature, owing to rapidity of reproduction, *Daphnia* soon reach a peak or maximum in numbers as the water warms up and food in the form of minute algæ and infusoria becomes plentiful. This period of maximum numbers does not last long and is followed by a protracted period during which the number of individuals becomes less and less, until they finally die out altogether. As explained in Part 1, however, the imported *D. magna* can be cultured in ponds by the addition of fertilisers. This is a larger form than the native species and has, in addition, the advantage that the culture can be maintained throughout the year. Numerous fertilisers can be used for this purpose. Embody (10) advocates a mixture of three parts of soya-bean meal to one of superphosphate. Langlois (10) advocates a mixture of three parts of sheep's manure to one of superphosphate. Both these mixtures are easily obtained and are cheap and effective.

Larger fish require more substantial food and small fish are best for this purpose. There are two types of forage fish, viz., small varieties, or the fry of suitable larger species. The disadvantage of the first group is that, if present in large numbers, they compete with the small game fish for food and are inclined to feed on the very small bass as they rise from the nest. On the other hand, if bass are very plentiful they are inclined to destroy the entire stock of forage fish. Species such

as bluegills and tench constitute the second type of forage fish, where the adults cannot be destroyed but their young constitute forage for the major game species. Swingle and Smith (13) maintain that bluegill sunfish and largemouth bass constitute the ideal combination. The results of their various tests indicate that approximately one-third of the total weight of fish in a pond should be composed of carnivorous forms and two-thirds of forage fish. According to them, each acre of water, if correctly fertilised, should be stocked with approximately 400 bluegills and 30 largemouth bass. Good fishing in the shortest time was obtained by stocking in autumn or winter with bluegills and bass fingerlings as near the same size as possible. The bluegills reach the legal

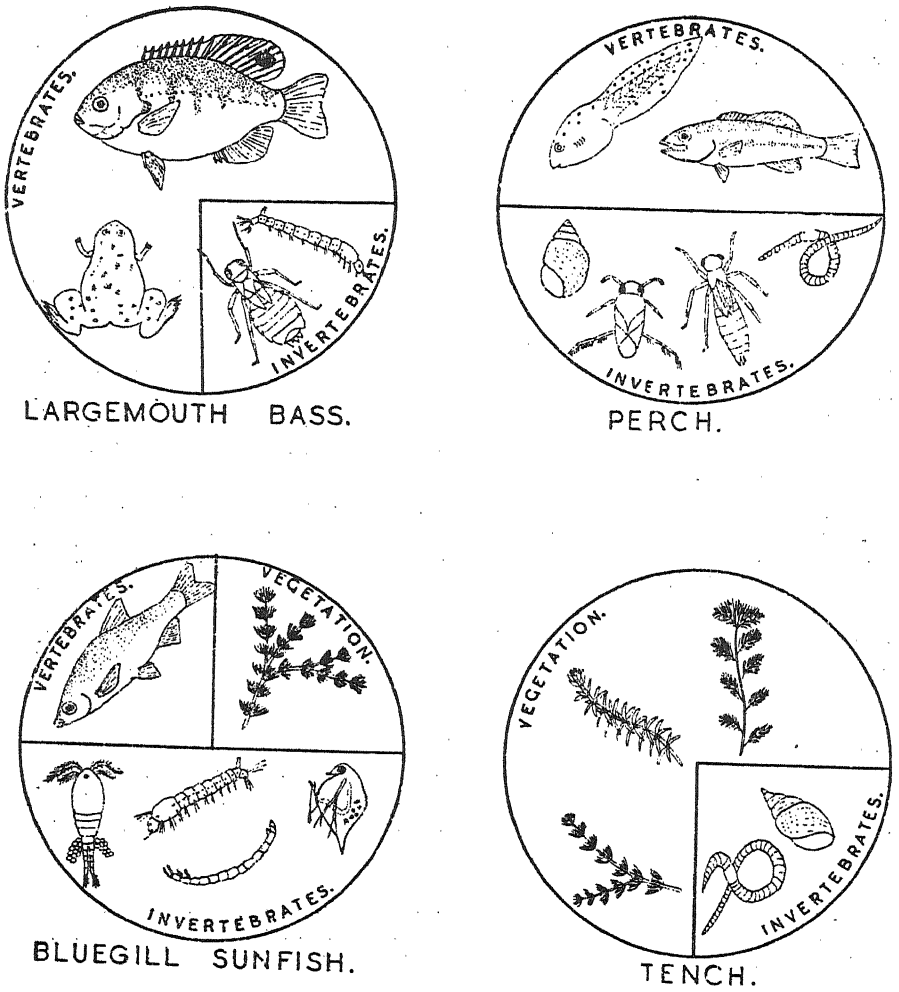


FIG. 10.—The food of fish.

size by the middle of the following summer and the bass by early autumn. Good results were also obtained by stocking with bluegills in the autumn and with bass fry the following spring. Fishing in such dams should be commenced as soon as the bass have reached the legal size in order to reduce the number to be carried through the winter.

In South Africa most notably in Paardevlei, Somerset West, largemouth bass and tench have proved a very good combination. Stomach counts by Harrison (7) prove that the greater portion of the diet of the bass consisted of young tench. Furthermore, tench, being vegetarians, do not compete with bass fry for animal food.

Harvesting the Crop.

In commercial fish farming not only must one prepare the dam, fertilise it and manage the crop, but one must harvest it at the correct time. Productivity should be calculated in terms of poundage per acre per annum rather than in the number of fish caught. Netting or draining are the usual methods of gathering a crop of fish for commercial distribution, and angling when the project is devoted primarily to sport fishing.

It is best to gather a crop of fish during the winter months, especially when they are to be transported alive for long distances. Not only are the fish less active at this time, and consequently easier to handle, but the water is cooler and contains more oxygen. They should be removed by first netting the shallower portions of the dam with a suitable net and finally the kettle (the deeper portion at the outlet), the water level being lowered if necessary. If the fish are to be held temporarily prior to distribution, small auxiliary ponds provided with running water should be used for the purpose. The fish should be kept in this manner for as short a period as possible, as it is impracticable to feed them under these conditions and they will rapidly lose condition.

If they are to be transported alive to the market, ten gallon milk cans, clean drums, etc., as described in Part 2, p. 27, may be used. Since conditions vary with locality, it is impossible to formulate a rule as to the number of fish of a given size that can be carried per gallon of water. The number of fish transported, however, can be considerably increased by aerating the water with a hand pump.

Literature Cited

1. Anon.: Artificial propagation of Carp. U.S. Dept. of Commerce, Bureau of Fisheries Economic Circular, No. 39. 1919.
2. Anon.: The Carp a valuable food resource. U.S. Dept. of Commerce, Bureau of Fisheries Economic Circular, No. 31. 1917.
3. Cooper, G. P.: Food habits, rate of growth and cannibalism of young Largemouth Bass *(Aplites Salmoides)* in State-operated rearing ponds during 1935. Trans. Am. Fish. Soc. Vol. 66. 1937.
4. Culler, C. F.: Notes on warm water fish culture. *Progressive Fish Culturist,* No. 36. 1938.
5. Dymand, J. R.: The Smallmouth Black Bass and its conservation. Ontario Dept. of Game and Fisheries. Bulletin 2. 1931.
6. Glen Leach, C.: Artificial propagation of Pike Perch, Yellow Perch and Pikes. U.S. Dept. of Commerce Bureau of Fisheries. Doc. No. 1018. 1927.
7. Harrison, A. C.: Black Bass in the Cape Province. Dept. of Commerce and Industries, Fisheries and Marine Biological Survey Division. Invest. Report No. 7. 1936.
8. Hutchins, D. E.: More about Carp. *Agricultural Journal of the Cape.* 1904.
9. James, M. C.: Propagation of Pondfishes. U.S. Bureau of Fisheries, Doc. 1056. 1929.

10. NEEDHAM, P. R., and BROWN, L. A.: Notes on the use of Water Fleas as fish food. Trans. Am. Fish. Soc., Vol. 63. 1933.
11. PRINCE, EDWARD E.: The place of Carp in fish culture. Supplement No. 1 of the 29th annual report to the Department of Marine Fisheries. 1897.
12. PROBST, E.: Die künstliche Befruchtung bei Karpfen und Schleien. J. Neumann, Neudam und Berlin. 1938.
13. SWINGLE, H. J., and SMITH, E. V.: Managing Pondfish production. *Progressive Fish Culturist*, No. 53. 1941.
14. TATE REGAN, C.: The Freshwater Fishes of the British Isles. Methuen & Co., Ltd., London. 1911.
15. VIOSCA, P.: Pondfish culture. The Pelican Publishing Co., New Orleans, U.S.A. 1937.
16. WIEBE, A. H.: The pond culture of Black Bass. Bulletin No. 8, Game, Fish and Oyster Commission, Austin, Texas. 1935.

IV. THE ECONOMIC IMPORTANCE OF INLAND FISHERIES

FISH is of primary importance in a nation's diet. On account of its enormous size and the fact that it is self-perpetuating, the sea is the major source of supply in all countries. Unfortunately, fish is a highly perishable article. Although available in large quantities to people living at the coast, and in spite of the improved methods of preserving fish, it is impossible to distribute it throughout the interior of a country where transport facilities are limited.

In most countries this deficiency is met by an adequate supply of freshwater fish. Europe, by virtue of her age, leads in this respect and carp, tench, trout and bass are a common commodity.

In America, with her large natural lakes and artificial reservoirs, inland fisheries play a very important role. A census of commercial fishing on three reservoirs during 1940 showed that over 900,000 pounds of fish were caught, the average catch per fisherman being 500 pounds per month. During that year it was estimated that 1,340 persons were supported wholly or in part by commercial fishing. Those who devoted their full time to fishing had a net income of $600 per year. In addition, the fish caught constituted the major portion of the diet of these people, the average annual consumption per family of four being estimated at 507 pounds (2). According to Sherman (4), the Bureau of Foreign and Domestic Commerce of the U.S. Dept. of Commerce has estimated the approximate annual consumption of all fishery products (fresh, smoked and canned) in the United States at 15 pounds per capita, one-tenth of this being supplied by the inland fisheries. Great strides have been made in the development of inland fisheries since that estimate was made, so that the present figure is probably considerably higher. In central and east Africa, too, inland fisheries are of economic importance, freshwater fish forming the staple article in the diet of many native tribes.

With anti-waste campaigns and conservation figuring prominently in present-day economics, the time has arrived for inland fisheries to be developed and placed on a sound basis in South Africa. If the consumption of fish in this country could be raised it would contribute considerably towards solving the problem of malnutrition. There are three reasons for this low consumption. In the first place, fresh fish is only available at the coast. Secondly, there is a prejudice in some

districts that fish is a "poor man's food" and, thirdly, there is a lack of skill in the preparation of fish for the table.

With the number of excellent exotic species of fish at our disposal we are now in a position to develop our waters to the fullest extent. This may be done in two ways: firstly, by stocking all public waters. During the past two decades the Irrigation Department has devoted large sums of money to the construction of irrigation reservoirs. Some of these are large sheets of water covering as many as 39,000 acres. These waters could, in addition to their present important function and at a very small cost, be employed in the production of fish. Estimating production at the low figure of 200 pounds per acre, the 21 largest of them could alone produce 7,000 tons of fish per annum. Besides being a valuable food resource, the catching of these fish would provide employment for a number of families. Secondly, every farmer should utilise at least one of his dams for the cultivation of a suitable variety of freshwater fish. By doing this he would be able to provide his family and labourers with fresh fish daily and thus do a great deal towards solving the problem of malnutrition.

The adage that the best things in life are the cheapest is most apt when applied to fish. They are a healthy and nutritious food, can be cultivated at smaller cost and less labour than any other crop, give a greater yield per acre and, in conclusion, provide entertainment while being reaped.

The Dietetic Value of Fish

Of recent years increasing attention has been paid to the nutritional value of fish. This applies mainly to sea fish and is largely the result of improved methods of preserving fish such as freezing, canning, drying and smoking, which have brought this commodity within reach of the consumer.

Because fish is adapted to live at very low temperatures it is among the most perishable of foods. In the absence of low temperatures it deteriorates rapidly from bacterial invasion and autolysis, since the high degree of activity of the digestive and autolytic enzymes of fish is a necessary adaptation to the low temperatures of its natural environment (4). For the same reason, fish is cooked at a temperature far below that required for meats and also in a very much shorter time. The economic advantages of this fact to the housewife are obvious and, in addition, fish is easily digested and widely used as a food for invalids. The superior digestibility of fish as compared with meat is also due to the fact that the connective tissue binding the muscle fibres together is composed of collagen tissue which is easily broken down by the digestive juices of the stomach, whereas in meat it consists of elastin tissue which is far less easily digested. Since fish are supported in their medium without exertion, their muscle fibres are far shorter than those of terrestrial animals which support themselves by their own effort (5). Consequently, fish is never too tough, being masticated and digested very easily. From most standpoints, fish may be regarded as interchangeable with meats, the main constituent of flesh, viz., protein, being essentially the same in both cases, although the protein content is generally slightly higher in fish as shown by Fox and Goldberg (3) in the table below.

TABLE I.

AVERAGE CHEMICAL CONSTITUENTS OF MEAT AND FISH.

Item.	Constituents.							
	Grams per 100 grams.			Milligrams per 100 grams.				Cals. per lb.
	Protein.	Fat.	Carbohydrate	Mineral salts.	Ca.	P.	Fe.	
Roast beef	13·5	34·1	—	—	8	145	3·5	1,669·0
Mutton	16·0	33·1	—	0·8	12	213	3·0	1,642·0
Pork	16·6	30·1	—	1·0	10	179	1·3	1,530·0
Fish	19·0	2·5	—	1·3	25	287	13·0	445·0

Fish shows the same mineral deficiencies as meat and grains, but the calcium, phosphorus and iron content is generally higher than meat. Sea fish also provide a fairly rich source of iodine which is, however, lacking in freshwater fish. Fat fish is a very rich source of the fat-soluble vitamins A and D which are extracted mainly with the liver oil. Vitamin A prevents night blindness and is the most important vitamin for healthy tooth formation in growing children and the resistance to infection. Vitamin D prevents rickets which are so prevalent in our undernourished population to-day. The outstanding importance of fish in the prevention of malnutrition cannot, therefore, be over-emphasised. Since the fat content of fish is, on the whole, comparatively low, it is highly acceptable to those on a slimming diet.

In Japan large quantities of fish are eaten raw, but this is not the case in Europe and America. The slight changes which occur in cooking consist chiefly in the loss of moisture when fish is cooked by dry heat, and loss of soluble proteins when the fish is cooked in water or steam (4).

Since frozen fish soon loses much of its palatability and canned, smoked and dried fish are beyond the means of the poor man as a staple article of diet, the advantages of an adequate local supply of freshwater fish for the inland population need no emphasis.

Table II, adapted from Sherman (4), indicates the average composition of freshwater fish as estimated in America.

TABLE II.

AVERAGE COMPOSITION OF FRESHWATER FISH.

Kind.	Constituents.				Calorific value.
	Protein %	Fat %	Carbohydrates.	Ash.	
Black Bass	20·6	1·7	—	1·2	99·0
Catfish	14·4	20·6	—	0·9	243·0
Eels	18·6	9·1	—	1·0	156·0
Mullet	19·5	4·6	—	1·2	120·0
Perch	18·7	0·8	—	1·2	8·2
Trout	19·2	2·1	—	1·2	96·0

Preparation of Fish for the Table.

The treatment fish receives before it is cooked is of more importance than the actual cooking, and the following are the essential principles in preparing the different varieties of freshwater fish for the table.

Fish should be cleaned as soon as possible after being caught and, if it is to be kept, should be salted down the backbone, wrapped in paper and placed in the shade. Under no circumstances should fish, intended for the table, be allowed to lie in the sun or in a hot enclosed space.

Bass and bluegill sunfish must be scaled, perch and tench should be skinned, but trout need only be wiped with a damp cloth as the skin, besides being crisp and tasty when cooked, contains valuable food elements. Small fish may be cooked whole but larger fish should be cut into sections or filleted. In order to do this, remove the head, tail and fins and split down the mid-dorsal line until the backbone is exposed. Next, run a soft knife between the ribs and the flesh on both sides of the body, and it is a simple matter to remove the skeleton. Fish such as carp and tench, which often have a muddy flavour, should be allowed to stand overnight in salt water or, if the fish is to be cooked sooner, in lemon juice, when the muddy flavour will disappear.

The texture of the flesh varies in the different species and only fish from unpolluted sources should be used for the table. Trout flesh is fine-grained and readily separates from the small bones. Although only slightly inferior to the flesh of trout, that of bass and perch is more flaky and contains fewer bones. Carp and tench are inferior to the above-mentioned species and in addition they contain numerous fine bones.

Cooking improves the flavour of fish, and frying, baking and boiling are the commonest methods employed. Fried fish is much richer than boiled fish and contains 60 calories per ounce as compared to 29 in the latter; 5·5 gm. of protein as compared to 6·4; 3·4 gm. of fat as compared to 0·4; and 1·8 gm. of carbohydrates as compared to 0·5. Fish to be fried must be dried with a soft cloth after having been cleaned and washed. It should then be dusted lightly with flour, brushed with egg and covered with breadcrumbs. After this it is placed in smoking hot fat, oil or butter, which is hot enough to harden the surface immediately. It is important that there always be sufficient fat to cover the fish. Frying should be continued at a lower temperature, but the process should not last longer than from seven to ten minutes. When boiling fish, the water should be neither too hot nor too cold. If the water is too hot the skin will break, whereas if it is too cool much of the flavour will be lost in bringing it up to the boil. After the boiling point has been reached, the water should be allowed to simmer gently to prevent the flesh from disintegrating. The smallest quantity of water should always be used for boiling, since it can be used afterwards as the basis of a fish sauce or soup. As soon as the flesh separates from the bone the fish is cooked. In the case of carp and tench a little lemon juice should be added to the boiling water to remove any muddy flavour which might persist.

The following methods of testing the freshness of fish as supplied by Anderson (1) might prove useful:

1. Presence of rigor mortis.
2. Fresh smell.

3. The absence of a reddish discolouration on the ventral side of the backbone.
4. When fish is fresh it requires considerable pressure to strip the flesh from the backbone and in doing so may tags of flesh are left adhering to the bone. As decomposition and consequent softening progresses, the flesh gradually strips off cleaner.
5. The abdominal walls are firm and elastic.
6. The gills are bright red.
7. The eye is full and prominent with jet black pupil and transparent cornea.

Literature Cited

1. Anderson, A. G.: How to tell whether fish is stale or unfit for food. Undated.
2. Bryan, Paul and Clarence M. Tarzwell: A preliminary report on the census of commercial fishing in T.V.A. impoundments. Trans. of the 6th N. Am. Wildlife Conference. 1941.
3. Fox, F. W., and L. Goldberg: Approximate chemical composition and vitamin content of common South African foodstuffs. Biochemical Department, S.A.I.M.R. Undated.
4. Sherman, H. C.: Food products. The Macmillan Co., New York. 1933.
5. Von Bonde, C.: Harvest of the seas. Escom, No., 1941.

SUMMARY

This article in its four parts (Part 1 in Issue 6, Part II in Issue 7, and Parts III and IV in the present issue of this Journal) indicates in broad outline how freshwater fish may be cultivated for economic or sporting purposes. This may be done in the majority of reservoirs without interfering radically with their present function.

Part I deals with the improvement of dams and streams for fish. Although most dams are constructed primarily for the conservation of water and are unsuitable for fish culture, they may be used for this purpose by repairing all leaks, preventing erosion of the walls, screening of inlets and outlets, adapting them for complete drainage and by providing spawning facilities and cover for the fry. The importance of fertilisers in building up food chains is explained, and the kinds and amount of fertiliser that should be used are indicated. Various species of aquatic plants, their function and control are described. The secret of successful pond fish culture is an adequate food supply. Natural food supplies can be augmented by the use of forage organisms such as *Daphnia*, top-minnows, tilapia, bluegills and tench.

Since lakes are too large to be controlled as prescribed for dams, they may be improved by increasing the natural food supply, improving spawning conditions and providing shelter for the fish.

The purpose of stream improvement is to create and maintain better living conditions for the fish by providing additional shelter, preventing extreme seasonal changes in the volume and temperature of the water, and by improving the food supply. This may be done by constructing small weirs at intervals along the stream bed and by the judicious use of deflectors.

Part II explains the methods of stocking rivers and streams with suitable fish such as trout, smallmouth and spotted bass. The distinguishing features, requirements (temperatures, streamflow, oxygen content, acidity, turbidity and food supply), life history and economic value of each of these species is described in turn.

The methods of stocking with trout ova and fry and the use of various types of hatching apparatus such as natural gravel beds, the "Chaplin" hatching tin, the floating hatching box and hatching trough are described. A brief description of stripping is also given. The economic possibilities of culturing trout for culinary purposes are discussed. It is not practicable to strip bass, and for stocking purposes fingerlings or adult bass must be used. The method of obtaining brood stock, transporting and stocking are described.

The management of a fishery consists of conserving the natural resources, restocking, maintaining spawning facilities and controlling predators. A brief description of scale reading is included in this section.

Part III deals with the stocking of dams and reservoirs with species such as largemouth bass, perch, bluegill sunfish, carp and tench. Each of these species is fully described, giving life history, habitat, tolerance, stocking methods and economic and sporting values. The maintenance of dams with regard to stocking, fertilising, forage fish and harvesting the crop are comprehensively dealt with.

The economic importance of inland fisheries and the dietetic value and preparation of fish for the table are discussed in the fourth and concluding section.

NOTES ON THE SYLVICULTURE OF THE INDIGENOUS FORESTS

By F. S. LAUGHTON

(Senior Forest Research Officer, Division of Forestry.)

THE question of the best methods of managing the indigenous forests of the Union is one which has engaged for many years the attention of forest officers and others interested in the maintenance of the small area of forest with which we have been endowed. The problem is one of considerable complexity and very little has been written which may act as a practical guide to those responsible for their management. In the meantime so great have been the demands made on the forest by a rapidly expanding European population that almost its entire area has been already exploited. In some forests exploitation has been extremely heavy: in others fire or cyclones following exploitation have destroyed large areas and reduced others to scrub, or "kreupelbos," as it is called. The problem of the rehabilitation of these forests is extremely difficult.

From time to time forest officers have propounded various theories as to the correct manner of exploiting the forests. Some have recommended very light sectioning and others clear-felling. These theories have often been acted on so that one has several areas in which one may observe the results of their application. In general, however, it is practically impossible to obtain a detailed history of any forest. The problem is further complicated by the fact that there are now very few unexploited forests, undisturbed by fire or heavy grazing, so that it is difficult to visualise what a forest looked like before it was disturbed.

There has in the past been a tendency to regard all the forests as being essentially of a single type. For instance, the fact that the clear-felling of a particular portion of one forest has resulted in the establishment of a dense growth of trees and shrubs, whereas in another area light, selection fellings have disturbed the forest so little that few, if any, tree-seedlings have become established, has led certain officers to recommend that clear-felling is the only satisfactory method of regenerating the forests as a whole. Actually the forests occur on widely-differing types of locality which affect the distribution of species and the establishment of seedling regeneration.

It is difficult to compress into one short paper a description of most of the different types of locality in which one may find indigenous forests but an attempt to do so is made here, with suggestions for the management of each type. The attempts are necessarily sketchy and I have made no attempt to explain the conclusions to which I have come as a result of several years' intensive work in the forests. I can only hope that these notes are sufficiently logical for anyone to follow and that they may be useful, even if only as a basis of discussion.

The principal factors governing the distribution of the forests and of their component species and the establishment and growth of the seedling trees

are soil-moisture and soil-aeration. It is on these factors that the classification adopted is based. One of the principal factors governing the aeration and moisture-retentive capacity of a forest soil is the formation of a mulch of litter on the surface of the soil and the incorporation of the humus in the soil.

The amount of litter reaching the soil in any locality is obviously dependent on the nature and the density of the plant-growth upon it. The incorporation of the litter in the soil, is however, dependent on a variety of factors. The decomposition of the litter is primarily dependent upon fungi and a host of other agencies, insect, bacterial, etc. These again are dependent upon moisture, air and temperature and also, therefore, upon the texture of the soil, the moisture relations of the soil and the type of soil-cover. This obviously opens up a wide field of research. Certain facts are, however, well-known and may be briefly summarised here.

(a) In swampy localities, where aeration is the limiting factor the decomposition of the litter in our warm climate proceeds rapidly, at least to a point, and the products of decompositon are incorporated in the soil.

(b) On sandy soils, where moisture is the limiting factor on account of the drainage through the sand, the rate of decomposition is slower but here again the products of decomposition are incorporated into the soil.

(c) On certain intermediate sites, where the surface soil is constantly moist but not water-logged, there is a very gradual transition from the undecomposed litter on the surface to the mineral soil, the whole forming a mulch—porous, well-aerated and capable of retaining large quantities of moisture. The limits of these intermediate sites are narrow. In dry localities, where drainage is good or where there is a long dry-season, as in the winter-rainfall areas of the Cape, there is an abrupt transition beneath a forest canopy between the slightly or undecomposed litter and the mineral soil, while in moist localities, especially under open stands, the rate of decomposition of the litter is so great that it is rapidly incorporated in the soil. In these moister sites a considerable thickness of mulch and humus above the mineral soil may be found under dense, vigorous stands, which both make strong demands on the soil and deposit large quantities of litter, but the thickness of the mulch is greatly reduced and many disappear altogether as the stands thin themselves out and decline in vigour and in their demands on the soil.

The chief fact elicited by a study of the root-system of the climax species of our forests is that they are practically confined to the humus and to a few inches of the surface soil. A few anchoring roots may penetrate the soil to a depth of two or three feet but the great majority of the feeding roots display a tendency to come out of the mineral soil into the narrow horizon of mulch and humus. As an instance of this fact I may say that I have removed the complete root system of an over-mature kamassi, presumably several hundred years old, using no tools except my fingers and a knife to cut away the roots of other trees

intertwined in it. A similar tendency may be noticed in the root-systems of pines, gums and other trees introduced into this country but these root-systems resemble more closely those of our indigenous pioneer and semi-pioneer species, which develop originally a strong, deep root-system and later, as a humus-horizon is built up in the soil, a feeding root-system in the mulch and humus. The climax species are able to establish themselves and to grow vigorously only if a well-aerated surface horizon is provided. The stag-headedness of isolated trees of such species as real yellowwood and ironwood in heavily exploited forests is usually to be attributed to the decomposition of the mulch and humus and the compacting of the soil due to direct exposure.

The superficial nature of the root-system of the climax species may be noticed even on sandy and other naturally well-drained and well-aerated soils. Related to this is the fact that the feeding roots of all these species are associated with endophytic fungi, which are probably able to break down, and to extract plant-foods from, the mulch and humus, so that the surface horizon is for them the most fertile.

The most important of the climax species of the high forests are:— real yellowwood, ironwood, kamassi, stinkwood, assegai, vlier, red alder, white alder and lemonwood. Of these, stinkwood is naturally adapted to deep, well-aerated soils, such as those found over broken rock, which are supplied with abundant moisture. Red alder is adapted to constantly moist, shallow soils very rich in humus, white alder and vlier to constantly moist, somewhat deeper soils, and lemonwood to moist, clayey soils. East Griqualand yellowwood, although a climax species, belongs to a different class in that, although it requires a very well-aerated soil in which to develop as a seedling, it is a species of heavy, moist, clay soils, which its roots penetrate to a considerable depth.

The most important of the semi-pioneer species are Outeniqua yellowwood, white pear, red pear, hard pear, essenhout, kaffirplum, camdeboo, wild peach, boekenhout, kershout, rooihout, terblans, bastard saffraan, fynblaar ysterhout, bastard black ironwood, white ironwood, knobwood and wild chestnut. These are species naturally occurring on deep, well-aerated soils. Certain of them, such as Outeniqua yellowwood and white pear (and, at Gouna, terblans) are able to adapt themselves to shallow but well-aerated humus built up over poorly aerated clays, which the roots barely penetrate. The bastard black ironwood (*Olea capensis*) is particularly adaptable and may be found on sites as variable as the rear coastal dunes and the *Blechnum capense* swamps of certain Midland forests. The occurrence of the remainder of the species mentioned may be taken as an indication of a deep, well-drained soil, though the nature of the soil may vary greatly.

The classification of forest types attempted here is based on drainage and soil aeration. It must not be assumed from the number of unfavourable types of locality described that these types cover the greater part of the area of the indigenous forests. No classification of the area of the forests on this basis has yet been attempted but the total area of the favourable types must be very considerable.

I. Forests on Well- and Super-Drained Sites

(a) *Forests on deep beds of sand.*

The chief forests of this type in the Union are at Alexandria and at

Harkerville near Knysna. The former covers about 6,300 morgen whereas the area of the latter included in this type probably does not exceed 5,000 acres.

Alexandria Forest is growing on old dunes where the sand is everywhere over 100′ in depth. The forest extends several miles along the coast and about four miles inland. The highest dunes are probably about 300′ above see level. Conditions within the forest vary considerably and the forest from low scrub near the sea and on the crests of some dunes to forest with a general height about 70′. There are no running streams in the entire reserve and drainage is everywhere severe so that even in the moistest localities the forest is open. The principal forest species are Outeniqua yellowwood, sneezewood, kaffirboom, septee *(Cordia caffra), Strychnos decussata,* fynblaar ysterhout, *Olea exasperata,* essenhout, boerboom, white ironwood and, in certain areas, Cape box. The forest floor is densely covered with kissieblaar (*Isoglossa ecklonіana*) and large openings in the canopy are usually densely covered with creepers or shrubs, such as *Rhamnus prinoides* and *Scutia myrtina.*

Even the best of this type of forest yields very small quantities of timber but it is obvious that the moister portions of it are excellently suited to the growth of *Pinus insignis.* The object of management in this type of forest, therefore, would appear to be the finding of markets for the principal species occurring there so as to permit their exploitation and the gradual conversion of the better portion of the forest to this pine. The determination of the best and cheapest methods of doing this would require a considerable amount of preliminary work. The potentially valuable box forests are worthy of special investigation to determine how they may be regenerated and improved.

At Harkerville the sand is derived from the relatively old Knysna Beds, which were deposited upon the Table Mountain sandstone. In the course of centuries much of this sand has been eroded away. In many parts the T.M.S. is now exposed at the surface and probably nowhere does the sand now exceed 50′ in depth. The sandy beds are now found mainly on the crests of broad ridges and along the streams towards which the sand has been washed. These facts are mentioned as a warning that the whole of this reserve does not consist of the type now under discussion. Some of it belongs to the types described under II(c) and III(b).

In the areas of the type now under discussion the principal species are hard pear, boekenhout, kershout, Outeniqua yellowwood and rooihout with scattered specimens of essenhout, knobwood, thorn pear and other species typical of well-drained sites and a variable stocking of the climax species, real yellowwood, ironwood, kamassi, assegai, white pear and stinkwood. These climax species have invaded this type as a result of the well-distributed and relatively high rainfall (about 40″) and the amount of humus accumulated in the soil.

In some areas of this type drainage is so severe that the stocking of the forest is very open and the trees are small. On such sites there is usually a dense soil cover of *Polystichum adiantiforme* (the 30-day fern) and *P. pungens.* Such sites are usually intrinsically too poor to justify any treatment but some of the moister sites might profitably be converted to *Pinus insignis.*

Over the greater part of the remainder of the forest of this type there is a rather open stocking of usually small trees the general height of which does not exceed 70′. There is often a very open understorey of such

shrubs as onderbos (*Trichocladus crinitus*), numnum (*Carissa bispinosa*), and pendoring (*Gymnosporia buxifolia*) and a soil-cover of the two ferns before mentioned. Large openings in the canopy caused during exploitation are normally soon invaded by bitou *(Osteospermum moniliferum)*, a short-lived, soft-wooded shrub under which tree seedlings sometimes establish themselves, though such areas are frequently invaded and held for many years by the two species of fern mentioned above.

The chief difficulty in the establishment of seedlings in this type of locality is obviously the severity of the drainage. To protect the soil from direct exposure to the sun and to maintain the supply of litter to the soil, the object of management in this type of forest should be to maintain a practically complete canopy and to maintain the vigour of the stocking as far as possible by scattered light fellings which will remove (as far as this is compatible with the first object) over-mature, mature and valueless trees (suppressed, diseased or of valueless species).

(b) *Forests on Bokkeveld or Ecca Shales.*

Where forests are found on soils of this type the shales are usually exposed on the steep slopes of valleys. Much of the forest at Grootvadersbosch near Swellendam, Groot River (Nature's Valley) near Knysna, the Bathurst Forest and the scrub along the Fish River is of this type. The drainage through the shales on sites of this type is so severe that the forests can never develop into anything better than scrub nor be capable of producing timber of larger dimensions than fence-poles. The intensive management of such forests is impracticable.

Forests of a somewhat better type may be found towards the bottom of the valleys and the possibility of producing timber trees be indicated by the actual growth of the trees. If such forests are of sufficient extent to justify management, they should be treated in the same way as that recommended for Harkerville above.

Forests of high quality on these soils are found practically only on alluvial soils in the beds of valleys, where an abundant supply of moisture is assured. On such alluvial beds Outeniqua yellowwood is usually the dominant species. It may, indeed, be found forming pure forest on alluvial beds derived from Ecca conglomerate, T.M.S. and a variety of soils many miles from any area of forest. As the humus content of the soils is increased and a layer of litter is built up above the mineral soil other species (such as white ironwood, wild chestnut and camdeboo on the higher, better drained areas, vlier, whitewood and white alder on the lower, poorer-drained sites and the climax species on intermediate sites) frequently invade these areas. On account of the chemical fertility of sites of this type weed-growth is usually severe and even small openings in the canopy may become invaded with creepers and other weeds. In the regeneration of this type of forest, therefore, it may be necessary to resort to planting and intensive weeding. Outeniqua yellowwood would be the obvious species to select for any such planting, though, amongst exotics, Californian redwood *(Sequoia sempervirens)* shews great promise on such sites. If planting be resorted to in the regeneration of forests of this type, the exploitation of the forest should be designed to create group or strip openings not greater in diameter or width than the height of the surrounding trees, so that the areas planted may be freed from the competition of the surrounding trees, which will, however, afford considerable protection to the soil in the opening.

(c) *Forests on Precipitous, Rocky Slopes.*

Although a sufficient depth of soil may accumulate on ledges in this type of site to produce well-grown trees, it is obvious that they can never be exploited economically and they will, therefore, be left undisturbed.

(d) *Forests on Screes and Broken Rock.*

At the foot of, and on ledges in, steep hillsides there is frequently a considerable accumulation of broken rock. Where forests occur on such sites, the vigour and density of the forest naturally depends primarily on the severity of the drainage through the rock; that is, on such factors as the depth of the scree, the steepness of the slope on which the scree is piled, the height above the stream or drainage plane, the amount and texture of the soil washed between the broken rock and so on. In the "bosklofies" in the Midlands sites of this type are frequently found, and, where there is a sufficient supply of moisture, the forest may consist almost entirely of stinkwood and hard pear; or such a forest may have a screen of red alder above the scree on moist, shallow, humus-rich soil; or, where enough soil has accumulated, the forest may contain a considerable admixture of assegai, kamassi and other valuable climax species. In fact in some forests of this type kamassi is the only species of the understorey. On the other hand drainage in this type of site may be so severe that the forest consists of a poorly grown, open stocking of such species as bastard black ironwood, wild peach, camdeboo, white pear and *Halleria lucida*. Forest on this type of site may, in short, vary from the most valuable to the utterly useless. The usual indicators of a well-drained site, the ferns *Polystichum adiantiforme* and *P. pungens*, are normally present.

The necessity of maintaining an adequate supply of moisture to forests of this type is obvious and the severity of the exploitation of any forest will be governed by the danger of drying out the soil to such an extent that its regeneration will be difficult or impossible or that the development of the trees will be deleteriously affected. The poorer forests of this type will not be worked at all while in the best types the regeneration of stinkwood from coppice and of kamassi from coppice and layers should normally be adequate.

(e) *Forests on Clayey Soils on Exposed slopes or in Areas of Low Rainfall.*

Considerable areas of indigenous forest are growing on clayey soils derived from T.M.S., Malmesbury or Beaufort shales, or dolerite. Presumably in undisturbed conditions over a long period of years forests growing upon these clayey soils on well-drained, exposed slopes were able to build up an appreciable depth of litter and humus and thus provide suitable conditions for the development of valuable species. Sites of this type are frequently found on the lower slopes of mountain ranges, where the rainfall, in the absence of the mists frequently experienced at greater elevations, is marginal. In such localities forests were easily accessible and in a number of cases (e.g. between George and Knysna, in the Pirie Forest near King Williamstown and near Uitenhage) the exploitation of the forest was so severe that the valuable, porous, surface soil was eroded away. Such sites now carry scrub forest and it is difficult to see how their present condition can be improved in any

calculable period of time. The only feasible plan is to introduce some of the less demanding exotic conifers in strips cut through the scrub. The cutting open of strips through the scrub will often be expensive and the young transplants will be subjected to the competition of the remaining scrub and the weed-growth and also to the browsing of buck. Species naturally adapted to heavy soils, such as *Pinus canariensis* and *Cedrus deodara,* are probably best suited for this purpose but obviously a considerable amount of experimental work is required before specific recommendations can be made.

II. Forests on Moist, Poorly-Aerated Soils

(a) *The East Griqualand Yellowwood* (Pod. Henkelii) *Forests.*

These forests are found in East Griqualand and Natal within the mist-belt in areas of high rainfall. They are confined to heavy, clay soils, derived from dolerite and the Beaufort shales. The forests are normally practically pure, giving way on better aerated soils to stinkwood, sneezewood, common yellowwood, camdeboo, wild peach and other species. The ground flora in these forests usually consists of grass (*Oplesminus hirtellus*) and *Selaginella kraussiana* and a very scattered shrubby undergrowth of *Peddiea africana.*

East Griqualand yellowwood bears a heavy crop of seed annually. The seeds which fall early in the season (about April—May) are heavily parasitised and infertile but practically 100% germination may be obtained from the sowing of seed collected later. In spite of this, seedling regeneration in this type of forest is usually completely lacking. The reason for this is probably to be found in the rooting habit of the species. The roots of seedlings are extremely superficial and sensitive to soil aeration. Under nursery conditions seedlings thrive in a heavily mulched bed or in well-cultivated soil but fail completely in heavy, poorly aerated soils. As they grow and develop, however, the roots penetrate heavy soils to a considerable depth (about 6′ to 7′) and, although there is a great concentration of roots near the surface throughout the life of the tree, older trees can continue to grow vigorously even though the mineral soil is exposed at the surface.

These observations lead one to conclude that under natural conditions openings in the canopy caused by the death and fall of trees are normally invaded by shrubs and small trees, such as *Halleria lucida, Rhamnus prinoides* and *Buddleia salvifolia,* and that as these pioneers fall off in their demands upon the soil the yellowwood seedlings become established in the humus which has accumulated beneath them. I have never seen this stage in the succession though several forests have been heavily exploited. Possible reasons for this are the erosion of the surface soil consequent on the extraction of logs and the grazing of cattle in the forests, the rapid drying-out of the surface soil in heavily disturbed forests on exposed aspects and the rapid invasion of openings in moister localities by bracken and other moisture-loving ferns, which remain dominant on the soil for long periods.

To follow the natural succession on this type of locality means, in any case, waiting for a long period as none of the probable pioneer species are of any timber value. More intensive use may be made of the soil by felling the overwood in groups or strips wide enough to free the centre from the competition of the roots of surrounding trees and by planting



FIG. 1.—Type 1d. Large Stinkwood in Langni Forest, Transvaal.



FIG. 2.—Type 2a. East Griqualand yellow-wood in Tonti Forest, Transkei.

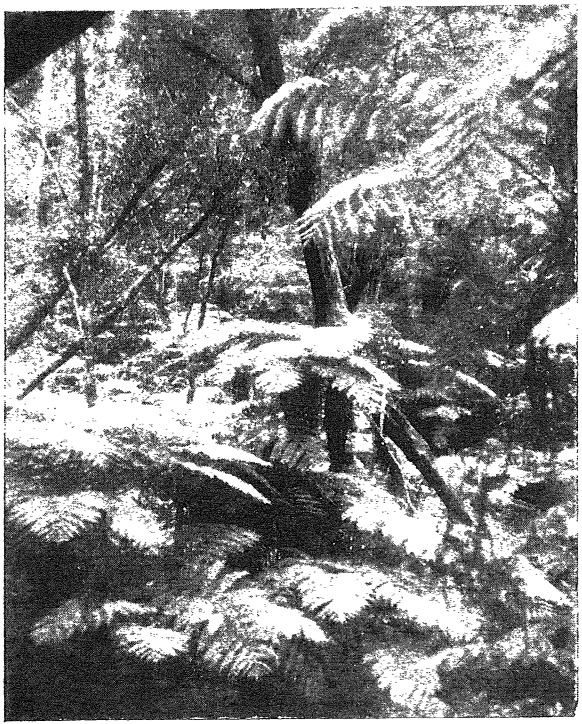


FIG. 3.—Type 3a. Sourflats Forest, Knysna. Dense cover of tree ferns as shewn inhibits seedling regrowth. Tree in centre is *Halleria lucida*.

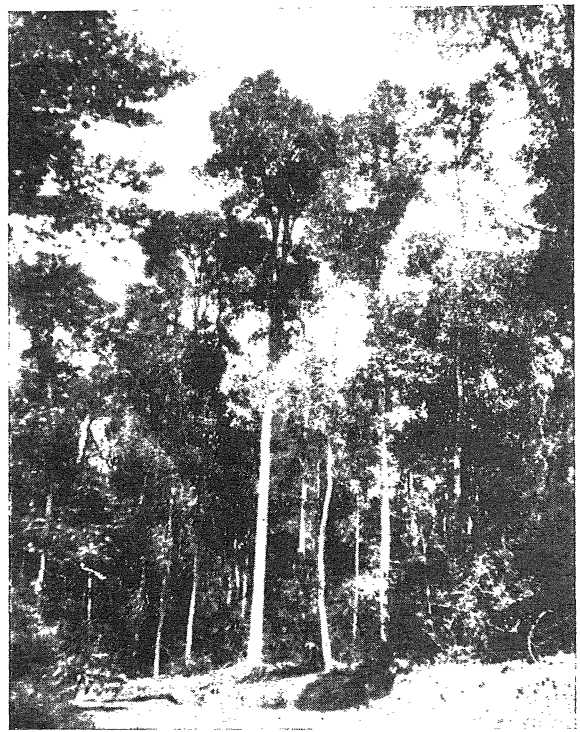


FIG. 4.—Type 3b. Lily Vlei Forest, Knysna.

a suitable exotic in the centre of each opening. The exotics, which will have to be protected against buck until they are well established, should be kept dense at first so as to build up a mat of litter and humus as quickly as possible and, when seedlings of yellowwood begin to appear, they should be thinned heavily to encourage the yellowwoods. Experiments on these lines are now being initiated.

(b) *Forests on Clay Soils in Areas of High Rainfall.*

Scattered throughout the Amatolas and the Transkeian mountains, particularly at high elevations, one may find open forests with very little regeneration or woody undergrowth, consisting mainly of the usual climax species and the more moisture-loving species, such as lemonwood, vlier and red alder. The forest floor is usually covered with *Oplesminus hirtellus*, the same grass as that found in the East Griqualand yellowwood forests. On account of the coarser-grained parent material from which the T.M.S. soils of the Midlands are derived, this type of forest is seldom found there.

In considering the reasons for the poor regeneration of forest of this type, the chief factors to be borne in mind are the sensitiveness of the roots of the climax species to soil-aeration and the difficulties, bearing in mind the texture of the soil and the high rainfall, of building up a good depth of litter and humus. The problem, in fact, is essentially the same as that of the falcate yellowwood forests except that the soils are not as compact as in those forests and that the species are incapable of penetrating deeply into the soil. The abundant and vigorous regrowth of indigenous species under exotics in localities of this type at Isidenge, Kologha and other plantations scattered throughout the Eastern and Transkeian Conservancies is sufficient to show the importance of a pioneer community to build up a suitable soil for the establishment of seedlings. This regrowth at Isidenge is particularly dense and vigorous under stands of *P. pinaster* now about 50 years old, which were established by very heavy, broadcast sowings and which throughout life have been thinned very lightly. On the other hand stands of oak of about the same age, although they have built up a good depth of mulch and humus, have admitted very few indigenous seedlings except in one area, where a broad strip has been cut open for a telephone line. These observations tend to show:—

(a) that there is no reason to fear that the acid humus produced by pines is unsuitable for the establishment and vigorous growth of our indigenous species.

(b) that the suppression of the overwood and the consequent reduction in the demands of the overwood on the soil is necessary to obtain the vigorous growth of the understorey and

(c) that surface feeding species such as oak even under conditions eminently suitable for the establishment and growth of the climax species, may exercise for many years so great a demand on the soil as completely to exclude these species.

In general, therefore, the method of regenerating forest of this type is exactly the same as that recommended for the East Griqualand yellowwood forests but a considerable amount of experience is required before recommendations for general application can be made.

(c) *Forests along Seepage Lines, in Swamps or other Very Moist, Poorly Aerated Soils.*

A considerable area of forest of this type may be found in the Midlands. It may be recognised by the very open stocking of very poorly-grown trees, of which the principal species are usually white alder, whitewood, bastard black ironwood and water-wit-els *(Brachylaena neriifolia)*. The forest floor is usually covered to a depth of 3′ -6′ with a dense growth of ferns, *Blechnum capense* and *Gleichenia polypodioides,* the latter of which frequently climbs up the trees to a height of 12′ or more. The soil in this type of forest consists of a very shallow horizon of wet peat over the normal clay subsoil produced in this region by the weathering of T.M.S. or over the unweathered rock. This type of locality is so poor that its management, exploitation or development need not be considered further.

III. Forests on Moist but Well Aerated Soils

(a) *Forests on Sandy or Loamy Soils in Areas of High Rainfall or in Sheltered Localities.*

This type of forest may be found throughout the Midlands, mainly near streams and on sheltered aspects at elevations above 2,000 feet; where the rainfall is high and mists occur frequently. In the latter case the soil is often pockety with accumulations of deep soil over the clay or between the outcropping rocks and with the clay or the rock appearing at the surface in other places. This type of forest, therefore, seldom covers large continuous areas but it is intimately mixed with poorer types. It generally represents forest of high quality, in which stinkwood is well represented amongst the other climax species. On shallow, wet soils within the type this forest normally gives place to white alder near streams and to red alder in the mountains. The forest floor is usually covered with tree-ferns (*Hemitelia capensis*), which when the forest is seriously disturbed, give place to bracken or to muishondblaar *(Plectranthus fruiticosus),* whereas the white and red alder soils when disturbed usually become covered with *Blechnum capense.* On the best-drained sites or where the soil is seriously exposed by very heavy fellings in the main canopy the tree-ferns may, however, give way to *Halleria lucida, Cluytia pulchella* or *C. affinis,* the normal pioneer species of drier types of forest.

These soils are intrinsically well-suited to the growth of the climax species but very frequently natural regeneration is retarded by the dense and persistent soil cover. Planting the most valuable species, such as stinkwood, Outeniqua yellowwood, kamassi and assegai, in openings in forest of this type shows considerable promise and cases have been recorded where transplants have maintained a rate of growth of 5′ a year in height. Great care must be exercised in this planting not to go beyond the limits of the type or to plant up very shallow soils, on which little success may be anticipated. The planted openings should be large enough to free the planting sites from the competition of the roots of surrounding trees and it is desirable to delay planting for two or three years after felling to allow time for the death of the roots of the felled trees and to allow the soil to become covered with weeds. These soils are very rich in humus and when they dry out they do so to such

an extent that they are wetted again with difficulty. Such dry soils are naturally very unsuitable for planting and it is best to wait until the soil is covered with weeds and so protected from direct exposure to the sun. To permit the transplants to compete with the weeds they should be 4′-5′ in height when planted. This in itself is a considerable protection against damage by buck and further protection is afforded by disturbing the weed-growth as little as possible. In order to maintain the vigour of the transplants it is important in the nursery to encourage the formation of a strong, superficial root system by mulching the beds frequently and heavily. This system is most efficacious but care must be taken when planting to keep the root-systems in the usually shallow horizon of well-aerated humus soil and not to put them into the clay sub-soil, where most of the roots will very soon die.

The white alder soils are usually unsuitable for planting as they are wet and too poorly aerated for other species. This species is usually found in the form of an old stool with a number of short, crooked coppice shoots rising from it. It is seldom, therefore, of much value. The tree is usually bushy and deposits a large quantity of litter annually. The feeding roots are extremely superficial and mainly dependent upon this litter. Any form of plant-growth beneath white alder is unusual on account of the intensity of its occupation of the surface soil, except where the soil is too wet for the vigorous growth of the trees. On sites suitable for the growth of the major climax species white alder is seldom able to compete effectively. The best method of treating the alder forests, therefore, would seem to be to fell the trees cleanly and to attempt to encourage by selection the most promising of the coppice shoots. The viability of the seed of white els is very low and seedling trees are very rarely found.

(b) *Forests on Soils with a Well-Aerated Surface horizon overlying Clay.*

In the introductory notes of this paper attention was drawn to the fact that under certain conditions of moisture it is possible for a forest to build up above the mineral soil a well aerated horizon of litter and humus. Thus, on a given type of soil (say, dolerite) one may find the surface of the soil so baked and hardened by direct exposure to the sun that the gradual merging of the litter and humus into the mineral soil is practically impossible; in a moist locality on a sheltered slope (as in the case of the Griqualand yellowwood forests) a dense, vigorous stand of trees may exercise a sufficient drainage action on the soil and deposit on it a sufficient quantity of litter to build up and to maintain this until its demands on the soil decline and the amount of litter returned to the soil is reduced; while on level ground in an area of high rainfall (as in the case of Manubi Forest described by Mr. N. L. King in Number 4 of the Journal) conditions may be suitable for the building up of this well-aerated surface horizon by the pioneer communities, which establish themselves in the heavily exploited forest, and for the maintenance of this horizon indefinitely unless the forest is again over-exploited.

This explanation is reiterated here to explain the wide but scattered distribution of the type of forest now under discussion. It is mainly, though not entirely, where the litter and humus form a persistent surface horizon of the soil that this type of forest is found. It occurs also where a shallow horizon of sand, sandy-loam or loam occurs over a subsoil of clay: and also it is found occasionally when the aeration of the surface

soil (particularly of soils derived from Ecca and Beaufort shales) is secured by the very active working of the soil by large earth-worms. The air and moisture relations of a soil affect also the distribution of these earth-worms, which are found neither in very dry nor in very wet soils. Unfortunately the roots of our trees are more sensitive to moisture than the earth-worms, for many areas may be found where conditions on these "wurm-drol gronde" are unsuitable for the establishment of a dense crop of trees.

Undisturbed forest of this type is very well stocked but it tends to assume the form of an even-aged forest with a fairly dense undergrowth of shrubs, such as onderbos (*Trichocladus crinitus*), and of the suppressed regrowth of the principal species. Heavily exploited forest of this type is rapidly restocked but there is a marked tendency for the pioneer and semi-pioneer species, such as notsung, red pear, boekenhout, klip-els and kershout, to persist for many years and to suppress the regrowth of the more valuable climax species. The shrubby undergrowth also often becomes very dense, while the whole regrowth is often bound together with various species of liane such as droog-my-keel (*Scutia myrtina*), blouboktoutjies (*Pyrenacantha scandens*) and wild grape (*Cissus cirrhosa*). The trees in large openings also tend to retain their lower branches and thus to be of little timber value. In such forests the competition for moisture is obviously too intense to permit the vigorous growth of any trees and, at the same time, the expectation value of the forest crop is so low, on account of the bad form of the trees, that one does not feel justified in spending considerable sums of money on the necessary cleanings and thinnings.

It is possible to prevent this set-back to the forest succession, in forests which still remain more or less intact, by careful selection fellings, which, while relieving the demands on the soil sufficiently to permit the more vigorous growth of the remaining trees and the establishment of seedlings in the larger openings, do not seriously disturb the forest conditions.

The system of working forests of this type, therefore, should be based on the contradictory demands of two factors, root-competition and the maintenance of the soil. In forests already recovering from serious over-exploitation it is difficult to justify the introduction of exotic species in spite of the low potental value of the existing crop. These forests are, in many cases, already twenty to thirty feet in general height. To open them up sufficiently to secure the establishment and vigorous growth of the introduced exotics will entail, at considerable expence, the removal of so large a proportion of the crop that the succession is put back seriously. The built up litter and humus will rapidly disappear and deleteriously affect the growth of the indigenous trees retained. These trees, being without overhead cover and freed suddenly from contact with neighbouring trees, will produce still larger crowns. The introduced exotics on the other hand will have to contend with the root-competition not only of the surface-rooting remaining trees but also of the dense weed-growth, which may confidently be expected and also with buck and creepers. Except under the most favourable conditions (from this point of view) the probable result of such an attempt would be the expenditure of considerable sums of money to get the exotics established and practically the clear-felling of the indigenous regrowth to give the exotics a chance to develop. Depending upon whether the root-system

of the remaining trees were able to adjust themselves to the changed soil conditions or not, the scattered remaining indigenous trees would either become stag-headed or so bushy that they would be useless as timber and merely a nuisance from the point of view of management when the establishment of the next crop came to be considered.

Work has been carried out at Deepwalls with highly encouraging results in forests in a fairly advanced stage of recovery from over-exploitation. It is, of course, impossible to make the indigenous species grow at anything like the rate of many of the exotic species of the plantations. The rate of growth is not, on the other hand, as incredibly slow as it was at one time thought and it can probably compare favourably with the rate of growth of many of the forests of Europe. To maintain the rate of growth thinnings on a ten-year cycle would seem to be advisable in this type of forest and the cycle should not exceed twenty years.

Conclusion

It is hoped that it will be possible to publish from time to time more detailed reports on the management of different types of forest. The present paper is intended merely to describe the various types and to indicate the most important factors to be borne in mind in determining the objects of forest management. With sufficient experience it is moderately easy to determine the type of forest from the composition and density of stocking of the forest and, more easily, by the ground flora. To extend our knowledge of soil indicators further field work and observations are required. Some of the more important soil indicators have already been mentioned.

Finally, it is necessary to point out that the soils and the forest types in an individual forest frequenly change abruptly and markedly so that, if an attempt is made at any time to base forest management on these types, a considerable knowledge of the types and their indicators will be required of those in charge of the forests.

The common names used throughout this paper are taken from the draft Standard Nomenclature for Timber published in No. 5 of this Journal, in October, 1940. The following are the botanical equivalents of common names used but not included in the proposed standard nomenclature.

Bastard black ironwood	= *Olea capensis* L.
Bastard saffraan	= *Cassine kraussiana* Bernh.
Boerboon	= *Schotia latifolia* Jacq.
Fynblaar ysterhout	= *Olea foveolata* E. Mey (not *O. Peglerae* C. H. Wright usually called *O. foveolata* in the Transkei.)
Kaffirboom	= *Erythrina caffra* Th.
Klip-els	= *Canthium Mundianum* Ch. & Schl.
Notsung	= *Halleria, lucida* L.
Septee	= *Cordia caffra* Sond.
Thorn pear	= *Scolopia Zeyheri* (Arn.) Szyszy.

Summary

As a result of twenty years of intensive research into the factors governing the regeneration of the indigenous forests, a classification is attempted of the types of locality in which the forests are usually found. Emphasis is laid on soil-moisture and soil-aeration. On this basis an attempt is made to decide the general principles on which the management of the forests should be based.

TREE-PLANTING FOR COMMERCIAL PURPOSES

By N. L. KING

(Chief Management Officer, Division of Forestry.)

NO one is likely to invest money in treeplanting for commercial purposes unless it can be shown that, barring possible losses from fire, climatic agencies, insect pests and fungus diseases, the proposition offers reasonable prospects of financial success.

Hitherto private enterprise in treeplanting on a commercial scale has been confined almost entirely to eucalypts and wattles, the former for mining timber and the latter mainly for tan bark with mining timber as a side line. These two crops have been popular with private growers for the reason that, depending upon site quality, they can be harvested in about 8 to 10 years after establishment. The day of these short rotation crops appears to have reached its zenith. The time is therefore opportune to examine the prospects in other directions. First of all we have members of the poplar family of which the grey poplar (*Populus canescens*) and Carolina poplar (*Pop. deltoides*) are of the greatest value in South Africa. The former is met with on many farms in the Cape, Orange Free State and high veld of the Transvaal in small patches or "poplar bushes." *Pop. deltoides* has been planted mainly in the eastern Cape, Natal and eastern Transvaal. Both species are exacting as regards moisture and soil requirements and can be grown successfully only on deep fertile soils where plenty of moisture is available throughout the year. The area suitable for their cultivation is consequently restricted to small patches here and there such as narrow strips alongside streams or vlei ground which can be properly drained. The wood of both is much sought after by match factories and is also useful for many other purposes such as ply wood, boxes and wood wool. At the current prices offered by match factories for suitable logs i.e. logs not less than 4 feet long and 9 to 24 inches in diameter, the growers should have no difficulty in realising at least 1s. per cu.ft. standing provided the trees are well grown and are situated within reasonable distance from rail. At this price a very handsome return will be realised. Unfortunately data in regard to the yield of *Pop. canescens* are scanty. Hubbard (1) gives the following particulars of a stand growing on a heavy clay loam 4 to 6 feet deep at Knol Vlei near Wolseley, Cape Province. Age 17 years. Number of trees per acre before thinning 810 After thinning 620. Mean diameter at breast height of trees after thinning 7.3 inches. Height 57 feet. Volume of wood per acre without bark 3,952 cu.ft. Figures published by Schiemer (2) shew that, at 15 years, the diameter growth of *Pop. deltoides* is more than double that of *Pop. canescens* at 17 years. Under conditions more favourable than those at Knol Vlei and with a heavier thinning regime *Pop. canescens* will undoubtedly show results much better than those stated above but it does not appear at all likely that a yield as high as from *Pop. deltoides* will be reached. Those who are interested

in the latter would be well advised to study Schiemer's interesting article (2). He states that a tree 15 inches in diameter at breast height is considered the most suitable size for match wood. His measurements of sample plots show that on first quality sites and with heavy thinning trees attain this diameter in 15 years and that the yield of wood 7 inches and over in diameter amounts to about 4,400 cu.ft. per acre. Schiemer also gives growth figures for second quality sites but states that "no one should establish a *Pop. deltoides* plantation for commercial purpose on sites that are not first quality." This statement is hardly borne out by his figures. If, as estimated, 15 inch trees can be produced in 20 years on a second quality site, there appears to be ample margin for profit. The question may well be asked as to how site quality is to be determined before planting is commenced. Unfortunately it is not possible definitely to assess a site quality until a crop of trees has been produced on the ground in question. A pretty shrewd idea may, however, be gained by digging trial pits and comparing the soil with that of a plantation growing on a more or less similar site in the neighbourhood. If the latter is a first quality site the trees, according to Schiemer, should have heights of 23, 55 and 72 feet at 5, 10 and 15 years respectively.

Before leaving the subject, attention should be drawn to the remarks made by the Director of Forestry on page 23 of his annual report for 1939/40 (3) in regard to the trial of hybrid poplars. The Oxford variety is said to show the best rate of growth (8 to 11 feet during the first year) and has the minimum number of branches. The Roxbury variety, though a vigorous grower, tends to produce many small branches and will therefore require considerable pruning. No information is available in regard to the quality of the timber but is is possible that one or more of the hybrids may prove to have advantages over *Pop. deltoides*.

For large scale planting we must turn our attention to conifers especially the pines from which the bulk of the softwoods of commerce are derived. Experience, extending over a long period, has proved that many species can be grown to maturity in South Africa and that the woods they yield can be put to many uses. The harder and heavier kinds are well suited to the manufacture of house building material while the softer and lighter kinds are suitable for the manufacture of box shooks and other products where strength is not of great importance.

From the view point of a private grower the objections to pines are no doubt the long period which must elapse before they reach utilizable size and the low monetary return in comparison with mining timber or tan bark. On the other hand the market is never likely to be glutted by locally grown pine timber for there is little likelihood of South Africa ever becoming entirely self supporting as far as softwoods are concerned. It should also be borne in mind that trees steadily appreciate in value and in course of time become a valuable asset which enhances the sale value of a property. Moreover if due care is exercised in the selection of species and site and if a plantation is well managed the owner may reasonably expect a fair rate of interest on the capital invested.

An invesment in a long range undertaking calls for much more careful consideration than a short rotation crop for the margin of profit is narrower and initial mistakes may not become apparent for a number of years. As there are no pines indigenous to South Africa we must have recourse to introduced species. These are not alike in their climatic requirements and are most likely to thrive in conditions nearly similar

to those of their natural habitats. The greatest care is therefore necessary to ensure that the most suitable species are chosen for a given area. Fortunately this no longer presents much difficulty, for the afforestation that has been carried on in the past serves as a reliable guide. We must, however, go further than this and make sure that the wood will fulfil requirements. For example, *Pinus pinaster* or *P. canariensis* may thrive in a certain area but if timber for box shooks is aimed at then neither would be suitable as the wood is too hard and too heavy for this purpose. It should also be borne in mind that some species grow much faster and produce a much greater volume of wood per acre than others. Although it does not necessarily follow that the greatest volume producer will prove to be the most remunerative this is generally the case.

Speaking generally it may be said that in the summer rainfall area treeplanting for commercial purposes is not recommended where the average rainfall is less than 35 inches a year. In this area much of the precipitation takes place in the form of thunderstorms and during these downpours a large proportion runs to waste. This loss of moisture by run off coupled with rapid evaporation considerably reduces the effective amount of the rainfall. In the winter rainfall area where steady rains occur and evaporation is low the minimum requirement may be placed at about 30 inches a year.

Of the more important species grown in South Africa, *P. insignis, P. pinaster* and *P. canariensis* are best suited to the winter rainfall area and *P. patula, P. longifolia, P. caribaea, P. taeda, P. palustris, P. teocote* and *P. insularis* to the summer rainfall area. The first three also do fairly well in the all-the-year-round rainfall area of the Cape midlands, along the mountains in Kaffraria and the Transkei and on the high veld of the Orange Free State and Transvaal. In the summer rainfall region these three species, particularly *P. insignis* and *P. pinaster,* are liable to attack by *Diplodea* following damage by hail and may succumb to the disease.

Fuller information about the species mentioned above must be given separately.

P. insignis. This species grows more rapidly and produces a greater volume of wood per acre than any other pine in the western Cape Province. Does best along the lower slopes of the mountains at an altitude of between 600 and 1,200 feet. Needs deep well drained loamy soils. Growth is unsatisfactory on the poor acid soils above the shale band which forms the base of the Table Mountain sandstone series. On first quality sites *P. insignis* reaches a height of 100 to 120 feet with a diameter of about 17 inches at breast height in 30 years. Total wood increment averages 360 cu.ft. per acre per annum. When freshly cut the colour of the wood is white but changes to light brown on exposure to the air. Slightly harder, tougher and stronger than Baltic deal. Green and dry weights average 61 and 33 lbs. per cu.ft. respectively. Suitable for industrial and agricultural boxes and building timber.

P. pinaster. Rate of growth much slower than *P. insignis.* On first quality sites trees from a good strain reach a height of 80 to 90 feet and approximately 14 inches in diameter at breast height in 40 years. Mean annual wood increment about 110 cu.ft. per acre. There are several strains of *P. pinaster* in South Africa some of which, especially the Italian, are stunted and heavily branched. The Portuguese strain on

the other hand grows more rapidly, and is less heavily branched. *P. pinaster* does best in situations similar to those preferred by *P. insignis* but will thrive high on the mountains in poor acid soils where *P. insignis* fails. Growth under such conditions is however not nearly so good as on more favourable sites. *P. pinaster* also makes fairly satisfactory growth in sandy soil at low elevations provided the soil is not calcareous. The wood is harder, heavier and more resinous than that of *P. insignis*. The colour is yellowish brown with pinkish heartwood. Green and dry weights average 63 and 37 lbs. per cu.ft. respectively. Rather too hard and heavy for boxes. Best suited to building material especially flooring, floor joists and rafters.

P. canariensis. On first quality sites reaches a height of 70 to 80 feet in 20 years with a diameter of 8 to 9 inches. The bark is exceptionally thick and averages about 33 per cent. of the total volume. Mean annual wood increment roughly 100 cu.ft. per acre. Canary pine requires deep well drained loamy soils for its best development, but will also grow on stiff heavy soils. Fails at high altitudes on poor acid soils. The wood is hard, heavy and very strong. Green and dry weights 70 and 43 lbs. per cu.ft. Much too hard and heavy for boxes but makes excellent flooring and could be used for any purpose where strength is needed. On account of its straightness, strength and freedom from heavy side branches this pine is better suited than any other for pole production. The poles need preservative treatment otherwise they are not durable in contact with the ground.

P. patula. This is the fastest growing of the pines suitable for the summer rainfall area. On first quality sites reaches a height of 115 feet and a D.B.H. of 18 to 19 inches in 30 years. Mean annual wood increments about 380 cu.ft. per acre. The tree develops heavy side branches. Best suited to well watered areas particularly the mist belt at between 3,000 and 5,000 ft. altitude. Not hardy against drought. The wood is white, weak when young, very light, soft and almost non-resinous. Green and dry weights average 63 and 26 lbs. per cu.ft. respectively. Used for industrial, agricultural, butter and egg boxes and building timber where strength is not of importance.

P. caribaea. Thrives over a wide area and under diverse conditions. Has so far proved very encouraging on suitable soil in the Knysna region, along the coastal belt into Zululand, along the mountains in the mist belt and even at higher altitudes where severe frosts are experienced. The tree is a comparatively recent introduction and consequently definite evidence of its ultimate success or otherwise is not yet available. It is very prone to form double leaders one of which should be removed when the trees are small. In sandy soil at Port Durnford on the Zululand coast trees 16 years old average about 56 feet in height and 9 to 10 inches in diameter at breast height. Mean annual increment is estimated at 300 cu.ft. per acre. Logs when freshly cut exude large quantities of resin. Green and dry weights 61 and 29 lbs. per cubic foot respectively. Thinnings are used for industrial and agricultural boxes. The timber when mature, should yield a substitute for pitch pine.

P. taeda. This species is almost as accommodating as *P. caribaea*. Although its rate of growth is only slightly below that of the latter, the species has little to commend it. In the eastern Cape Province it is not nearly as robust as *P. caribaea*, turns yellow in winter and dying back from the top is common. It is moreover heavily branched, inclined to

be crooked and the wood from immature trees is brash. Sawn boards often split when passing through the rollers of planing machines. The wood has a good colour and is used for industrial and agricultural boxes and would be suitable for house building material where strength is not of importance.

P. longifolia. This species is to the east what *P. pinaster* is to the west. Rate of growth slightly faster than cluster pine. On first quality sites reaches a height of about 55 to 60 ft. and a diameter of 10 inches, at breast height in 20 to 25 years. Mean annual wood increment estimated at 150 cu.ft. per acre. *P. longifolia* does not thrive in the coastal belt. On the mountains it prefers the lower slopes. Higher up in bleak situations it is apt to turn yellow and make poor growth. The wood is moderaely hard. Dry weight per cu.ft. is the same as cluster pine i.e. 37 lbs. per cu.ft. Rather hard and heavy for most kinds of box making. Best suited to house building material.

P. palustris. This species yields the pitch pine of commerce. It has not been planted very extensively in South Africa and no stands near rotation age are in existence. It is consequently not possible to speak of the ultimate result with any degree of certainty. At Port Durnford on the Zululand coast a few hundred acres have been established and look promising. The rate of height growth at this centre is much the same as *P. caribaea* but the volume increment is much less. Where the latter can successfully be grown there does not seem to be much object in planting *P. palustris.* Immature wood from thinnings weighs 28 lbs. per cu.ft. dry and is used for box making. When mature should be suitable for house building and other purposes where strength is needed.

P. teocote. This is one of the Mexican pines and was introduced about 1913. Small packets of seed were sent to various mountain s'ations and everywhere trees raised from this seed show extraordinary promise; in fact the rate of growth is almost as fast as *P. patula.* At Nqadu near Umtata plots of these species planted side by side in 1914 gave the following measurements in 1937:—

	P. teocote	*P. patula*
Height	72 feet	80 feet
Diameter at B.H.	14 inches	15½ inches

The stands were planted 4′ × 4′, first thinned to about 600 trees per acre at 11-12 years and again thinned to about 300 per acre at 22 years. The wood is very light (25 lbs. per cu.ft. dry) and was favourably commented on by private millers who regarded it as better than *P. patula.* There is a good deal of uncertainty regarding the identity of the tree which may possible be *P. pseudo-strobus.* Unfortunately it has not been possible to obtain further supplies of seed from Mexico and it is only during the last few years that small supplies have become available from stands in South Africa. Attempts to propagate the tree from cuttings met with no success.

P. insularis. This species is native of the Phillipine Islands. It has proved a rapid grower in South Africa but almost everywhere the trees are so crooked as to be practically worthless. At Baziya near Umtata a small plot contains a straight growing strain. This plot was planted 4′ × 4′ in 1920 and at 17 years the height and B.H. diameter of the trees averaged 55 feet and 10½ inches respectively. The wood is fairly soft, resinous, weighs 27 lbs. per cu.ft. dry and resembles Baltic deal

more closely than any of the other South African grown pines. If seed of a straight growing strain can be obtained the species appears to be a most desirable one to propagate.

From the foregoing it will be seen that in the winter rainfall area *P. insignis* is the greatest volume producer and in the summer rainfall area the three most important species are *P. patula, P. teocote* and *P. caribaea.* Possibly these species will also prove to be the most remunerative.

Too much emphasis cannot be laid on the necessity for exercising the greatest care in the selection of a site for a plantation. The better the site the higher the yield and the shorter the rotation. This is well brought out by Craib's (4) figures shewn in Table I.

TABLE I.

EFFECT OF SITE QUALITY ON YIELD.

Species.	First quality site.			Second quality site.		
	Rotation age. Years.	Total yield cu.ft.	Mean annual increment.	Rotation age. Years.	Total yield cu.ft.	Mean annual increment.
P. insignis	30	12,312	410	50	4,317	86
P. patula	30	12,776	425	50	4,878	97

Expressed in words, the yield of *P. insignis* and *P. patula* from a first quality site is about three times more than for a third quality site and the rotation is 20 years shorter. Both factors are of considerable importance as far as the financial side of afforestation is concerned. In actual practice it is seldom, if ever, possible to obtain a compact area of several thousand acres of ground of first quality site only. As a rule the higher slopes and ridges will probably be poorer. This fact should be allowed for when planning large scale operations. If there is a marked distinction between quality sites it may be necessary to divide the area into two or more working circles* to be managed under different rotations and sylvicultural regimes.

Great stress should also be laid on the question of marketing. Timber in the log is a bulky and low priced commodity which cannot stand heavy transport charges. These charges may be reckoned at about 1d. per cu.ft. for every 4 to 5 miles the wood has to be transported by road. If railage to distant markets must be added the grower must expect a corresponding reduction in the standing value of the timber. Several instances could be quoted where transport charges have been so high as to render small parcels of timber practically valueless to the growers. The transport difficulty could be overcome by establishing a plantation large enough to keep a sawmill fully supplied throughout the year. A medium sized

*A plantation may contain two or more species which must be managed under different regimes. In such a case the compartments containing the same species are grouped together into what is termed a working circle. Where site qualities show a marked difference it may be desirable to constitute two or more working circles for each species.

mill absorbs about 350,000 cu.ft. of round timber per annum and to yield this quantity in perpetuity a plantation of about 1,600 acres would be needed. This is beyond the financial resources of the average farmer but if several living close to one another co-operated in a scheme to establish the requisite area between them the problem of marketing would fall away. If a mill is run in conjunction with a plantation the production and utilization sides could be combined and any profits from the latter could be applied to the undertaking as a whole. The milling of timber in situ is essential in areas far from markets. For example a log of freshly cut *P. patula* weighs roughly 63 lbs. per cu. ft. If converted into box shooks the volume of the finished product will be about one-third of a cu.ft. and the weight approximately 9 lbs. Thus, as opposed to green logs, the weight to be transported will be reduced by 86 per cent. Moreover the finished products being squared can be handled more easily and packed more closely without damage to transport vehicles.

On account of the long time which must elapse between planting and the realisation of final yields it is essential that forestry operations should be conducted as economically as possible. In order to cut down costs of establishment, increase volume production, shorten rotations and obtain a higher percentage of knot free timber a radical change in policy was introduced in state afforestation a couple of years ago. This amended policy was based in the data put forward by Craib (4). Briefly, less intensive soil preparation, wider initial espacements, earlier and more drastic thinning regimes, depending upon site qualities, and pruning have been adopted. By these means it is hoped to obtain trees 17 to 18 inches in diameter at breast height for all species and for all site qualities, under rotations varying from 30 to 60 years. For details readers are referred to Craib's bulletin (4).

Data collected in respect of a large number of representatives state plantations show that where cheap native labour is employed the cost of afforestation i.e. raising plants, preparation of the ground, planting or sowing, blanking and weeding averaged £3 10s. 0d. per acre during the five years 1935/36 to 1939/40 and that for the same period the cost of fire-protection worked out at 1s. 3d. per acre per annum. By means of wider initial espacement and less intensive soil preparation it is probable that the cost of afforestation will be reduced. Possibly £2 10s. 0d. per acre would not be an unreasonable figure for areas where native labour is employed. It is, however, as well to sound a note of warning that less intensive soil preparation may give rise to difficulties with rodents which, on account of the cover afforded, muliply and often cause considerable damage to young trees. Where rodents are troublesome it is cheaper in the long run to adopt the more intensive method of ploughing or hoeing the ground before planting or sowing.

The rate of interest earned by an investment in tree-planting cannot accurately be determined until the final crop has been disposed of. Only then will definite figures of expenditure and revenue be available. In order to forecast the probable financial result of such an undertaking most, if not all, of the relevant data must be assumed. If the data on which the assumptions are based are sound, a reasonably accurate forecast can be obtained, provided no serious losses are sustained from fire, insects, fungus or climatic causes.

The question may first be looked at from the view point of a company or private individual who must borrow the required capital and pay

interest thereon. Capital will be needed for the purchase of ground, fencing, erection of buildings for accommodation of employees and storage, provision of water supplies, construction of roads and all expenses incidental to the establisnment, maintenance and protection of the plantation until it reaches maturity. Let us briefly examine these items of expenditure. On account of the long time—30 to 40 years—which must elapse between the date of establishment and final felling, interest charges, at a normal rate, will amount to more than the capital. These interest charges are liable to fluctuate from time to time according to the money market. The price of ground and initial works vary from place to place and the cost of afforestation depends not only upon the nature of the ground but also on the rates of pay for labourers. On the other side the productive capacity of the soil cannot be ascertained with certainty until a crop of trees has been grown on the area, nor can definite values be allotted to future thinnings and final yield.

From the foregoing remarks the difficulties in stating a case will be appreciated. For the purpose of this article it has been assumed that 1,600 acres will be afforested and that the costs, reduced to an acreage basis, will be as follows:—

	£	s.	d.
1. Cost of ground	3	0	0
2. Cost of buildings, water supply, fencing and roads	1	12	6
3. Preparation of ground, planting, blanking and weeding	2	10	0
4. Thinning at 6 years (First thinning only on second quality sites.)		6	8
5. Pruning first quality sites @ 5, 6 and 8 years second quality sites @ 6, 8 and 10 years at 10s., 7s. 6d. and 7s. 6d., respectively	1	5	0
6. Overhead and supervision charges, fire-protection and incidentals (annual)		8	0

The cost of thinning, other than as noted above, has not been included as this is more than covered by the sale value of the thinnings.

Items 1, 2 and 6 are regarded as being on the liberal side. As regards items 3, it may be said that the cost (£2 10s. 0d.) is based on labour at 1s. 6d. per diem. If a higher rate is paid, the cost will be somewhat increased.

We now come to the credit side of the account. As already indicated the yield will, in the first place, depend upon the species used and this will, in turn, be largely influenced by the quality of the soil. It is seldom, if ever, possible to obtain a large extent of ground of uniform quality. It must, therefore, be assumed that on 1,600 acres at least 1st. 2nd. and 3rd. site qualities will be represented. Let us, however assume that of the 1,600 acres 25 per cent. consists of first quality and 75 of second quality sites. Let us further assume that the ground is situated in the winter rainfall area of the Cape Province, that the species decided upon is *Pinus insignis*, that the initial espacement is 9′ × 9′ and that the thinning regimes in table II are followed. Lastly, let us assume that afforestation is spread evenly over the rotation periods, i.e. that one-thirtieth of the first quality sites is afforested each year and one-fortieth of second quality sites. From data that are available the yield of wood 5 inches and over may be placed as shewn in table III. The figures in the table are based on estimated yields, but there is evidence

TABLE II.

THINNING REGIMES.

1st. quality site.		2nd. quality site.	
Age in years.	Thin to (per acre).	Age in years.	Thin to (per acre)
10	330	6	210
15	220	18	150
20	150	25	110
25	125	40	Final felling
30	Final felling		

TABLE III.

ESTIMATED YIELDS PER ACRE.

1st. quality site.		2nd. quality site.	
Age in years.	Vol. per acre. cu.ft.	Age in years.	Vol. per acre. cu.ft.
10	360	18	540
15	840	25	800
20	1,200	40	5,900
25	640		
30	7,500		

to show that they can be realised provided due attention is paid to thinning, particulary during the early youth of the plantation. In this connection, it may be mentioned that on a first quality site at Tokai a stand of *P. insignis* 32 years old containing 173 trees per acre was clear felled during the great war and yielded 9,730 cubic feet of timber per acre, exclusive of bark.

We next come to the question of what values should be placed on thinnings and final yield. When the present war is over and trade relations revert to normal there seems to be no doubt that competition in the timber industry will bring about a considerable reduction in the price of manufactured timber and that log values will have to be adjusted accordingly. Whether prices will revert to pre-war levels remains to be seen. Log values quoted in table IV are considered not unreasonable. They are exclusive of felling, trimming and delivery of logs at roadside accessible to transport vehicles, the cost of which is estimate at 0.75 pence per cubic foot. First thinnings on second quality sites would be too small to be of value for saw purposes and have consequently been regarded as unsaleable.

TABLE IV.

ANTICIPATED LOG VALUES.

1st. quality sites.			2nd. quality sites.		
Age in years.	Approx. mean dbh. of trees felled. Inches.	Nett value per cu.ft. Pence.	Age in years.	Approx. mean dbh. of trees felled. Inches.	Nett value per cu.ft. Pence.
10	5.8	1.00	18	9.0	1.75
15	8.3	1.50	25	12.0	2.75
20	10.7	2.00	40	17.0	3.75
25	12.5	2.75			
30	17,0	3.75			

TABLE V.

ESTIMATED GROSS RETURN PER ACRE.

1st. quality sites.				2nd. quality sites.			
Age in years.	Volume. cu.ft.	Rate. Pence.	Value. £ s. d.	Age in years.	Volume. cu.ft.	Rate. Pence.	Value. £ s. d.
10	360	1.00	1 10 0	18	540	1.75	3 18 9
15	840	1.50	5 5 0	25	800	2.75	9 3 4
20	1,200	2.00	10 10 0	40	5,900	3.75	92 3 9
25	640	2.75	7 6 8				
30	7,500	3.75	117 3 9				

By adopting the yields and the values placed thereon as given in tables III and IV, the money returns work out as shown in table V. A summarised statement of debits and credits exclusive of interest charges is presented in table VI. Assuming that money is borrowed at 5 per cent.

TABLE VI.

SUMMARY OF DEBITS AND CREDITS.

Site quality.	Debits.			Credits.	
	Item.	Year.	Amount.	Year.	Amount.
			£ s. d.		£ s. d.
First	1-3	1	7 2 6	10	1 10 0
	5	5	10 0	15	5 5 0
	5	6	7 6	20	10 10 0
	5	8	7 6	25	7 6 8
	6	Annually	8 0	30	117 3 9
Second	1-3	1	7 2 6	18	3 18 9
	4	6	6 8	25	9 3 4
	5	6	10 0	40	92 3 9
	5	8	7 6		
	5	10	7 6		
	6	Annually	8 0		

TABLE VII.

ESTIMATED DEBITS AND CREDITS INCLUDING SIMPLE INTEREST AT 5 PER CENT.

Site quality.	Debits.					Credits.				
	Item.	Amount.	Interest.		Total.	Years.	Amount.	Interest.		Total.
			Number years payable.	Charges.				Number years allowable.	Accrued.	
		£ s. d.		£ s. d.	£ s. d.		£ s. d.		£ s. d.	£ s. d.
1	1-3	7 2 6	30	10 13 9	17 16 3	10	1 10 0	20	1 10 0	3 0 0
	5	10 0	25	12 6	1 2 6	15	5 5 0	15	3 18 9	9 3 9
	5	7 6	24	9 0	16 6	20	10 0 0	10	5 0 0	15 0 0
	5	7 6	22	8 3	15 9	25	7 6 8	5	1 16 8	9 3 4
	6	12 0 0		9 6 0*	21 6 0	30	117 3 9	—	—	117 3 9
	Total	20 7 6		21 9 6	41 17 0		141 5 5		12 5 5	153 10 10
2	1-3	7 2 6	40	14 5 0	21 7 6	18	3 18 9	22	4 6 7	8 5 4
	4	6 8	34	11 4	18 0	25	9 3 4	15	6 17 6	16 0 10
	5	10 0	34	17 0	1 7 0	40	92 3 9	—		92 3 9
	5	7 6	32	12 0	19 6					
	5	7 6	30	11 3	18 9					
	6	16 0 0	40	16 8 0*	32 8 0					
	Total	24 14 2		33 4 7	57 18 9		105 5 10		11 4 1	116 9 11

* Summation of charges on each year's disbursement.

simple interest and that the same rate of interest is allowed on items of revenue the final result will be found in table VII.

On the basis of these figures the nett profits will be for first quality sites £111 13s. 10d. or £3 14s. 6d. per annum, and for second quality sites £58 11s. 2d. or £1 9s. 3d. per annum. Taking the ratio of first and second quality sites as 1 to 3, the weighted average will be £2 0s. 6d. per annum. The profit earned would obviously be improved if suitable ground is acquired at a cheaper rate or if the expenses can be reduced or if better prices are obtained for thinnings and the final crop.

Let us now turn to the case of a farmer who has suitable ground which he can spare for treeplanting. Although it would be correct to debit the treeplanting account with the cost value of the ground, no direct outlay of capital is involved in this direction. Further, it is likely that little or no extra expense would be necessary on buildings, fencing, road-making, water supplies and overhead and supervision charges. On account of these reductions the financial result would obviously be much better than that of the case already discussed. Let us assume that items 1, 2 and 6 on the debit side are reduced to £1, 10s. and 2s. respectively. Calculations on the same basis as before will show a return of £4 10s. 4d. per annum from first quality sites and £2 6s. 1d. from second quality sites, the weighted average being £2 17s. 2d. per acre per annum. In all calculations an efficiency of 100 per cent. in the plantation was assumed. This is seldom, if ever, attained for losses from fire and other causes must be expected and allowance made for such contingencies.

Finally, let us look at the 1,600-acre plantation from the viewpoint of combining utilization with producion. From the inception of the plantation until the 45th year, the total annual yield of wood 5 inches and over in diameter works out as shown in Table VIII, the figures reflected in which indicate that sufficient timber to justify the establishment of a saw-mill will not become available until the 26th year. From the 40th year onwards the yield will be stabilised at round about 350,000 cubic feet.

TABLE VIII.

TOTAL ESTIMATED ANNUAL YIELDS FROM 400 ACRES FIRST AND 1,200 ACRES SECOND SITE QUALITIES.

Years from commencement.	Yield in cu.ft.		
	1st. Quality sites.	2nd. Quality sites.	Total.
1- 9	—	—	—
10-15	4,750	—	4,750
16-20	15,900	—	15,900
21-25	31,850	16,200	48,050
26-30	40,350	40,200	80,550
31-39	140,100	40,200	180,300
40-45	135,350	217,200	352,550

Calculations were also made on the assumption that instead of spreading afforestation evenly over the rotation periods the whole area will be afforested in a period of 10 years. The advantage is that, at a much earlier date, the yield from thinnings would be sufficient to justify the

establishment of a small saw-mill. The financial result is, however, not as favourable. A further disadvantage would be that in order to bring about the establishment of a regular series of age gradations clear fellings and subsequent regeneration must be spread over as many years as there are in the rotation and this, in turn, involves carrying some stands long beyond the rotation periods.

Many will recollect the acute shortage of timber in South Africa during the Great War and the sale of about 750,000 cubic feet of *Pinus insignis* timber from Tokai plantation near Cape Town. This wood was put on to the market in order to relieve, to some extent, the insistent demand for timber. This was the first occasion on which such a large parcel of South African grown pine had been offered for sale. The extraordinary high price which the timber realised aroused a great deal of interest and focussed attention on the value of treeplanting. The writer who had charge of Tokai plantation at the time, urged farmers in western Cape Province to plant pines, especially *Pinus insignis,* on any suitable ground they could spare for the purpose. With the exception of a few, the advice fell on deaf ears and no doubt many are today regretting they did not take the plunge. Had the advice been generally followed the combined efforts of farmers would have created an asset of national importance and contributed largely towards meeting the present needs of the country in respect of timber for box shooks and building material. It should, however, be borne in mind that twenty five years ago saw mills for the conversion of locally grown pine into box shooks and other commodities had not come into being and without an assured market for logs the reluctance of farmers to embark on treeplanting can well be understood. Today the position is quite different. Many saw mills are operating on wood derived from state plantations. Some are no doubt the product of the war but the majority have come to stay and South African grown timber will more and more find its way into the economic life of the country. Farmers may therefore rest assured that a market will exist for pine timber in the log provided it is well grown and within reasonable distance of centres of consumption or is in sufficient quantity to justify milling in situ. Many farmers are hesitant about treeplanting for the reason that they may not live long enough to derive any direct benefit from their efforts. To these the words used by the late C. J. Rhodes would apty apply "Whoever has the foresight to plant trees is creating a monument for himself and providing capital for his successors while the gain to posterity is incalculable."

References

1. Hubbard, C. S.: A Review of the Species of *Populus* introduced into South South Africa. Forest Dept. Bull. No. 18, 1926.
2. Schiemer, E. L.: The Growing of *Populus deltoides* in South Africa. *Jnl. S.A. Fy. Assn.* No. 5, October, 1940.
3. Division of Forestry Annual Report for the year ended 31st March, 1940. P. 23. Government Printer, Pretoria, 1940.
4. Craib, I. J.: Thinning, Pruning and Management Studies on the Main Exotic Conifers Grown in South Africa. Dept. of Agriculture and Forestry Science Bull. No. 196. Government Printer, Pretoria, 1939.

DEPLETION OF GROUND-WATER FLOW IN JONKERSHOEK STREAMS

By C. L. WICHT

(Forest Research Officer, Jonkershoek.)

GROUND-WATER flow is derived from seepage which is discharged into the stream-channel from underground storage in the catchment. It forms part of the flow at all times, and is alone responsible for maintaining streams during dry periods. It is increased by infiltration of rainwater, which replenishes the ground-water temporarily stored in the catchment, thus causing increased seepage into the stream. During dry periods ground-water flow becomes depleted, because of the drains on sources of supply due to evaporation and transpiration, and the seepage and flow of water out of the catchment. In streams, which are being investigated at the Jonkershoek Forest Influences Research Station, it frequently contributes over ninety per cent. of the total annual discharge. The concentration of rainfall in a few winter months in this region causes the streamflow to be unfavourably distributed over the year (Wicht, 40). During the critical summer months—January, February and March—when practically no rain falls, water supplies to urban and rural populations become severely restricted. Measures, which would increase the volume and decrease the rate of depletion of ground-water flow, would be of great value. In this paper a preliminary study of such flow from small, natural, untreated catchments at Jonkershoek, is presented. This investigation will ultimately provide a criterion for assessment of the effect of afforestation, veld-burning, grazing and protection of natural vegetation upon the stability of streamflow (Wicht, '39).

Recorder charts from Jonkershoek streams, giving a continuous record of ground-water flow during dry periods, show marked diurnal fluctuations. These are caused by evaporation and transpiration along the stream courses. They have been dealt with in detail in a previous paper (Wicht, '41). In the present study such daily depressions in flow have been ignored and the potential true ground-water flow, based on highest level recorded each day, has been used in all computations. It has been assumed that the daily losses of water reflected in the daily depressions occur in the stream-channel or in its immediate vicinity, and that only ground-water which has reached the streambed is affected. Hydrographs drawn without regard to these diurnal fluctuations show smooth decreasing dry-weather sections separated by spates made up of stormflow. These ground-water flow sections may be combined—starting with the highest and proceeding to the lowest—to form a characteristic ground-water depletion curve for the period covered by the hydrograph. Such curves reflect the salient features of ground-water flow, and it is proposed to discuss their construction and interpretation in detail.

The Construction of Ground-Water Depletion Curves

Robert E. Horton published what were probably the first curves of this type in 1903 (Horton, '33 and '35). In the following year he derived an equation for depletion curves from theoretical considerations. This equation was tested by fitting observed sections of ground-water flow taken from hydrographs to computed curves. Similar formulæ have subsequently been developed by other workers (Schaffernak, '35; Iwasaki, '34). The most suitable general form of equation is that used by Horton. It is:

$$Q_t = Q_o e^{-ct} \quad \ldots\ldots\ldots\ldots 1$$

where Q is ground-water discharge, e is the Naperian base, c is a constant determined from observed data, and o and t indicate commencement and end respectively of the depletion period.

Horton and others have developed the use of depletion curves for the separation of ground-water and storm flow in hydrological studies (Horton, '33; Hoyt and others, '36). Iwasaki in his study of the Tokio water-supply has provided a practical example of the use of depletion curves in determining the proportions of precipitation from a single storm, which ultimately reach the stream as storm- and ground-water flow (Iwasaki, '34). Vermeule (1894), Stewart (1911) and Meyer (1915) used somewhat different depletion curves for predicting ground-water flow (Mead, '19). In the forest influences investigation at Emmental in Switzerland, ground-water depletion curves were used to show differences in flow derived from two experimental catchments (Burger, '34). Many of these workers constructed the curves by mechanically shifting ground-water flow sections of the hydrograph until they appeared to lie on one connected curve. The use of depletion curves for these purposes appears justified in most cases; because, despite variations, the ground-water depletion in a given catchment does tend to conform to, what Horton has called, "the normal ground-water depletion curve." Horton has pointed out, however, that "normal depletion curves may differ to a considerable extent in different years or seasons in cases where there is direct abstraction of ground-water from the water-table by vegetation or evaporation" (Horton, '33). Burger has shown differences in depletion curves for summer and winter conditions (Burger, '34). The depletion curve is also affected by the wetness of the years (Schaffernak, '35). In wet years ground-water flow is not only appreciably greater, but the staying power of the stream is also increased, because the catchment becomes more saturated. The Advisory Committee on rainfall and run-off of the American Geophysical Union has, however, recommended the depletion curve method as the most definite and logical procedure available for estimating ground-water flow (Trans., '35).

In hydrological studies in which depletion curves are used to demonstrate variations in flow due to differences in size and topography of catchments, to variations in climate, and to changes in management, the curves should be determined directly from the ground-water flow sections of the hydrographs. Because the time-scale of ground-water flow depletion is continually being interrupted by the occurrence of stormflow this is no simple matter. A method by which a complete average depletion curve can be computed, for any given period, from all the ground-water flow observations within that period, has, however, been developed at Jonkershoek.

Depletion Regressions

The difficulty of combining separate sections of ground-water flow in one depletion curve has been overcome by assuming a fixed depletion period, and first determining the regression of flow at the end of the period, on flow at its beginning. This regression has proved to be linear, and from it an equation for the depletion curve could be deduced. The method will be demonstrated by using observations of ground-water flow made in Jonkershoek streams.

For the *Bosboukloof* stream, pairs of readings of ground-water flow in 10,000 gallon daily discharge units, were taken for a two-day depletion period. These pairs were then sorted into 50,000 gallon daily discharge classes and entered in a correlation table. The array means for classes of daily ground-water discharge before depletion were next computed. A graph was prepared in which the independent variate was daily ground-water discharge at time n, immediately before depletion, and the dependent variate was discharge two days later, i.e., at the time $n + 1$. Such a graph is reproduced in the top right hand corner of Fig. 1. It can be seen at once that the array means lie on what appears to be a straight line. A linear regression was next fitted to the data. The heavily weighted values show practically no deviations from the line, and the deviations of the lightly weighted values appear to be evenly distributed on both sides of it.

In computing the regression shown in Fig. 1 no readings of discharge were taken earlier than five days after spates. This interval was adopted in order to avoid the delayed effect of stormflow retarded in channel storage. Horton has demonstrated the disturbing effect of delayed stormflow (Horton, '35). On a computed normal depletion curve he plotted hydrograph sections of dry weather flow, so that the lower portions fell on the curve. The higher, steeper portions were then seen to turn up and away from the curve. This was ascribed to the accelerating effect of storm-flow out of a channel-storage on depletion. If readings are taken immediately after spates these steep portions are included in the computations of the depletion regression. When this is done the linear regression becomes less significant, the regression coefficient is lowered and there is a tendency towards curvilinearity.

The linear depletion regression function may be written:—

$$Q_{n+1} = a + b(Q_n - \bar{Q}_n) \qquad \ldots\ldots\ldots\ldots 2$$

where Q at the time n is daily discharge before depletion, and Q at the time $n + 1$ is daily discharge after two days' depletion. In Table 1 values of a (mean of dependent variate), of mean of Q at the time n (mean of independent variate), and of b (the regression coefficient) for readings started at various periods after spates are given. Means of dependent and independent variates must obviously become progressively lower, because mainly high discharges are discarded by lengthening the period. The regression coefficient is raised from .884 immediately after spates, to .919 five days after spates, and remains more or less constant at that level afterwards. The reason for this is, that as the delayed storm-flow was excluded more and more, the higher, steeper sections of depletion were discarded and the average decrease in rate of depletion became less. The coefficient consequently rose to an approximately constant value after five days, thus indicating that the delayed effect of stormflow had become negligible at that

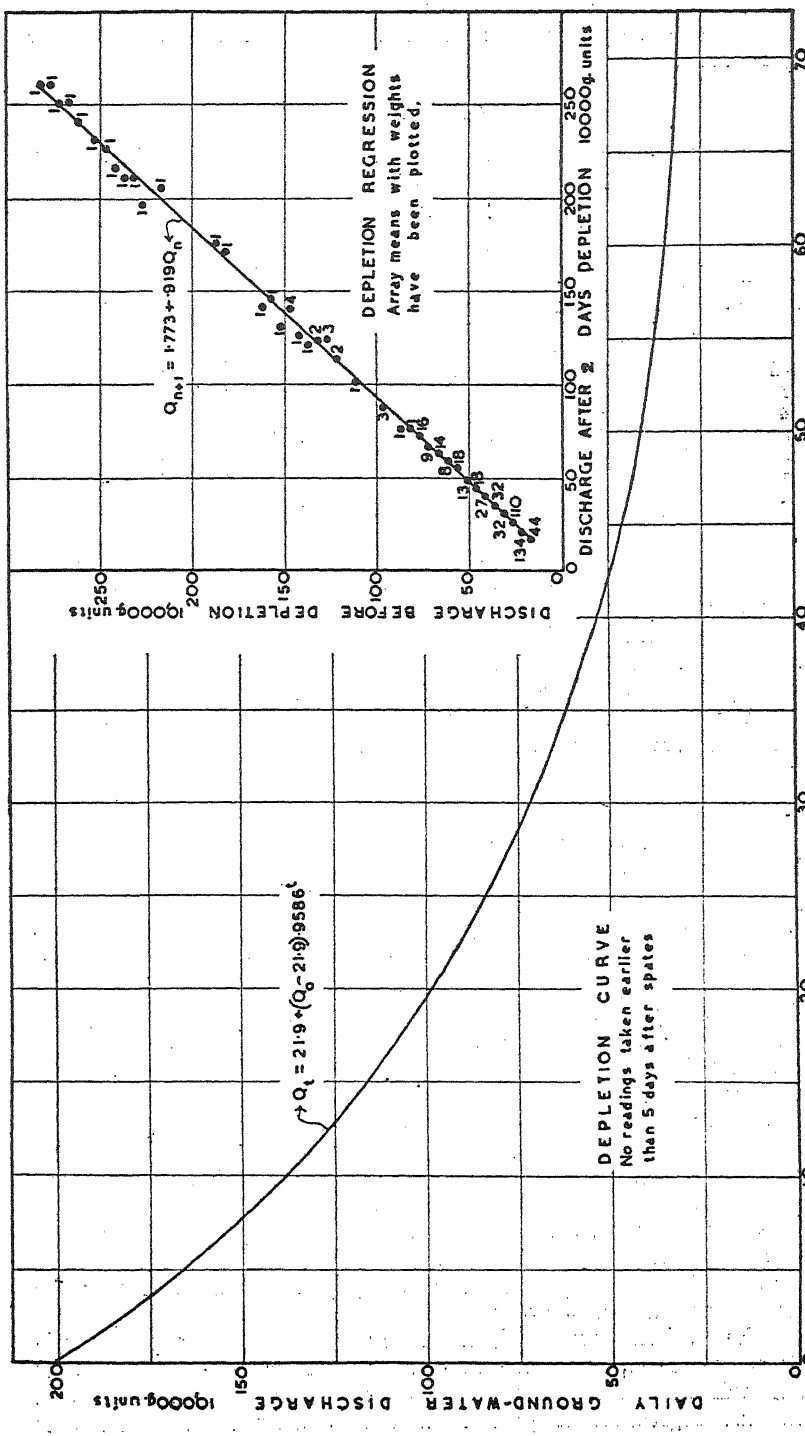


FIG. 1.—Linear regression and curve of ground-water flow depletion. Bosboukloof, 1938-'41.

time. If the period is still further lengthened the coefficient values will probably fluctuate irregularly because the number of observations will be seriously reduced.

TABLE I

VALUES FOR CONSTANTS IN EQUATION 2 SOLVED FOR 2-DAY DEPLETION PERIOD, AND FOR READINGS COMMENCING AT VARYING INTERVALS AFTER SPATES

No. days after spates	No. observations	Values for		
		a	b	Mean of Q at time n
Nil	855	49·677	·884	52·759
3	656	45·616	·902	47·977
4	582	43·641	·913	45·651
5	511	41·432	·919	43·155
6	449	39·094	·918	40·563
7	393	36·427	·919	37·649
8	348	34·328	·921	35·477

Before the regression of ground-water flow depletion was used for computing a depletion curve, it was examined in order to determine whether it was truly linear. In the study of the linearity of the depletion regression, observations of ground-water flow depletion from the *Bosboukloof* stream for the period 1938-'41, with no readings taken earlier than five days after spates, were mainly used. In addition to the linear regression already fitted, a curvilinear quadratic regression was fitted to these data. The function of this regression is:

$$Q_{n+1} = 1{\cdot}475 + {\cdot}93Q_n - {\cdot}000049Q_n^2$$

where Q at the time n is daily discharge before depletion, and Q at the time $n + 1$ is daily discharge after two days' depletion. It can be seen at once that the quadratic term is extremely small.

In Table II an analysis of variance (Fisher, '36) to test the significance of the ground-water depletion regressions is given. By subtracting values of half the natural logarithms and comparing the observed values of z obtained in this way, with the value read from a one percent table giving the distribution of z (Fisher and Yates, '38), Fisher's z-test may be applied. This test shows that the linear regression is very highly significant and the quadratic regression quite insignificant. It is clear also that the variance due to deviations from regression is low, and that higher order regressions are not likely to improve the fit significantly.

Depletion regressions for other streams at Jonkershoek have not been examined in so much detail, but in Fig. 2 linear regressions for the period 1940-'41, with array means, have been plotted for *Bosboukloof, Biesievlei, Tierkloof* and *Eerste River*. These all appear to be truly linear, though the catchments differ greatly in size, topography and consequently in the volume of ground-water flow (Wicht, '39).

From the evidence presented, the following deduction may be made for Jonkershoek streams: if the interval after rain, when the flow of streams is still influenced by stormflow—delayed in channel-storage—is neglected, the regression of ground-water flow after a unit period of

depletion on flow at the beginning of that period, will be linear. The next task is to find a suitable method of deriving average depletion curves from such linear regressions.

TABLE II

ANALYSIS OF VARIANCE: GROUND-WATER DEPLETION REGRESSIONS FOR BOSBOUKLOOF—1938-'41

No readings taken earlier than five days after spates.

Variance between arrays due to	Degrees of freedom	Sum of squares	Mean square	$\frac{1}{2}\log_e$
Linear regression	1	756,196·193	756,196·193	6·76801
Quadratic regression	1	11·576	11·576	1·22446
Deviations from regression	37	1,068·436	28·877	1·68152
Total	39	757,276·205		

For $P = \cdot 01$, $n_1 = 1$, $n_2 = 37$, $z =$ about 1

DERIVATION OF DEPLETION CURVES

Professor J. T. Morrison, of Stellenbosch, has derived the following series of equations from the linear depletion regression, which has been determined for a unit period of depletion of two days at Jonkershoek:

$$Q_1 = a + bQ_0$$
$$Q_2 = a + bQ_1$$
$$= a(1+b) + b^2Q_0$$
$$Q_3 = a(1+b+b^2) + b^3Q_0$$
$$Q_4 = a(1+b+b^2+b^3) + b^4Q_0$$
$$\vdots$$
$$Q_p = a(1+b+b^2+b^3+\ldots\ldots b^{p-1}) + b^pQ_0$$
$$= \frac{a(1-b^p)}{1-b} + b^pQ_0$$

If the unit period is one day we then have:

$$Q_{2p} = \frac{a}{1-b}\left(1-\sqrt{b}^{2p}\right) + \sqrt{b}^{2p}Q_0$$

and if we replace $2p$ by t, where t is the number of days we have:

$$Q_t = \frac{a}{1-b}\left(1-\sqrt{b}^{t}\right) + \sqrt{b}^{t}Q_0 \qquad \ldots\ldots\ldots\ldots 3$$

which is an equation for computing the depletion curve. This equation derived from actual observations is similar in form to the one which R. E. Horton derived from theoretical considerations in 1904 (Horton, '33). The first term disappears if the observed regressions pass through zero, because then the constant a in the linear regression function would become nil. The derived equation for the depletion curve would then be:

$$q_t = Q_0\sqrt{b}^{t}$$

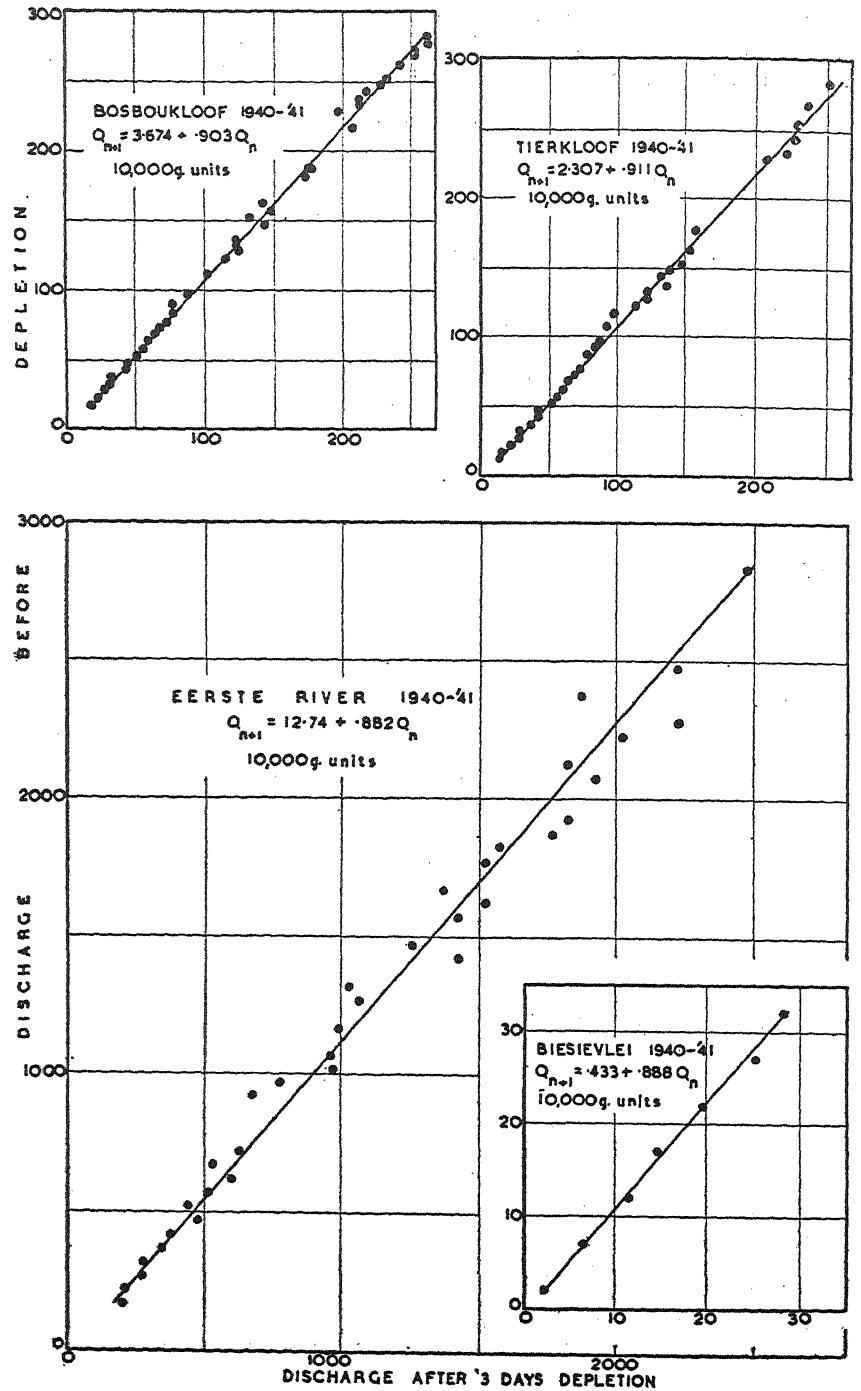


FIG. 2.—Linear depletion regressions and array means for four Jonkershoek streams, 1940-'41.

If we now put $\sqrt{b}$ equal to a constant which can be e to the power $-c$, we have Horton's equation (see equation 1).

The linear depletion function for *Bosboukloof* 1938-'41 is:

$$Q_{n+1} = 1{\cdot}773 + {\cdot}919Q_n$$

where the unit of discharge is 10,000 gallons per day.

Numerically the equation for the depletion curve derived from this function would be:

$$Q_t = \frac{1{\cdot}773}{1-{\cdot}919}\left(1-\sqrt{{\cdot}919}^{t}\right)+\sqrt{{\cdot}919}^{t}Q_0$$

Taking the initial discharge as 2,000,000 gallons this can be written:

$$Q_t = 21{\cdot}9+(200-21{\cdot}9){\cdot}9586^{t}$$

By solving this equation for various values of t the points required to plot the depletion curve in Fig. I were obtained. The curves shown in Fig. 3 were derived in a similar manner from linear regressions shown in Fig. 2. We have thus a method for computing an average depletion curve from all the available observations of ground-water depletion flow within the period being investigated. These curves should be of special value in hydrological experiments such as are being conducted at Jonkershoek, because the method of computation will make it possible to apply the theory of probability and test the significance of differences between curves statistically.

Interpretation of Regressions and Curves of Ground-Water Flow Depletion

The ultimate object of this investigation is to arrive at ways of presenting ground-water flow data, so that the effects on the flow of various systems of management applied in the catchments will be demonstrated. The functions of depletion regressions and curves appear to be suitable statistics for this purpose, and their interpretation must, therefore, be considered.

The linear depletion regression function for Jonkershoek streams (see equation 2) may also be written:

$$Q_{n+1} = a+bQ_n \qquad \ldots\ldots\ldots\ldots \quad 4$$

The constant value, a, serves to place the height of the line. It is zero if the line passes through the origin. Logically this is what would be expected for depletion regressions, because in a dried up stream where Q at time n equals zero, Q at time $n+1$ must also equal zero. The values of a in functions computed for Jonkershoek streams (see Figs. 1 and 2 and Table III) are low so that the regressions pass close to the origin. The fact that they always lie slightly higher than zero has not been satisfactorily accounted for. The constant value a in the regression function leads to an analogous constant in the derived depletion curve equation. If equation 3

$$Q_t = \frac{a}{1-b}+\left(Q_0-\frac{a}{1-b}\right)\sqrt{b}^{t} \qquad \ldots\ldots\ldots\ldots \quad 5$$

is converted to the form (in Table III): this constant is represented by the first term. It indicates that streams do not deplete to zero, but to a constant base-flow. The source of such a base-flow has not been

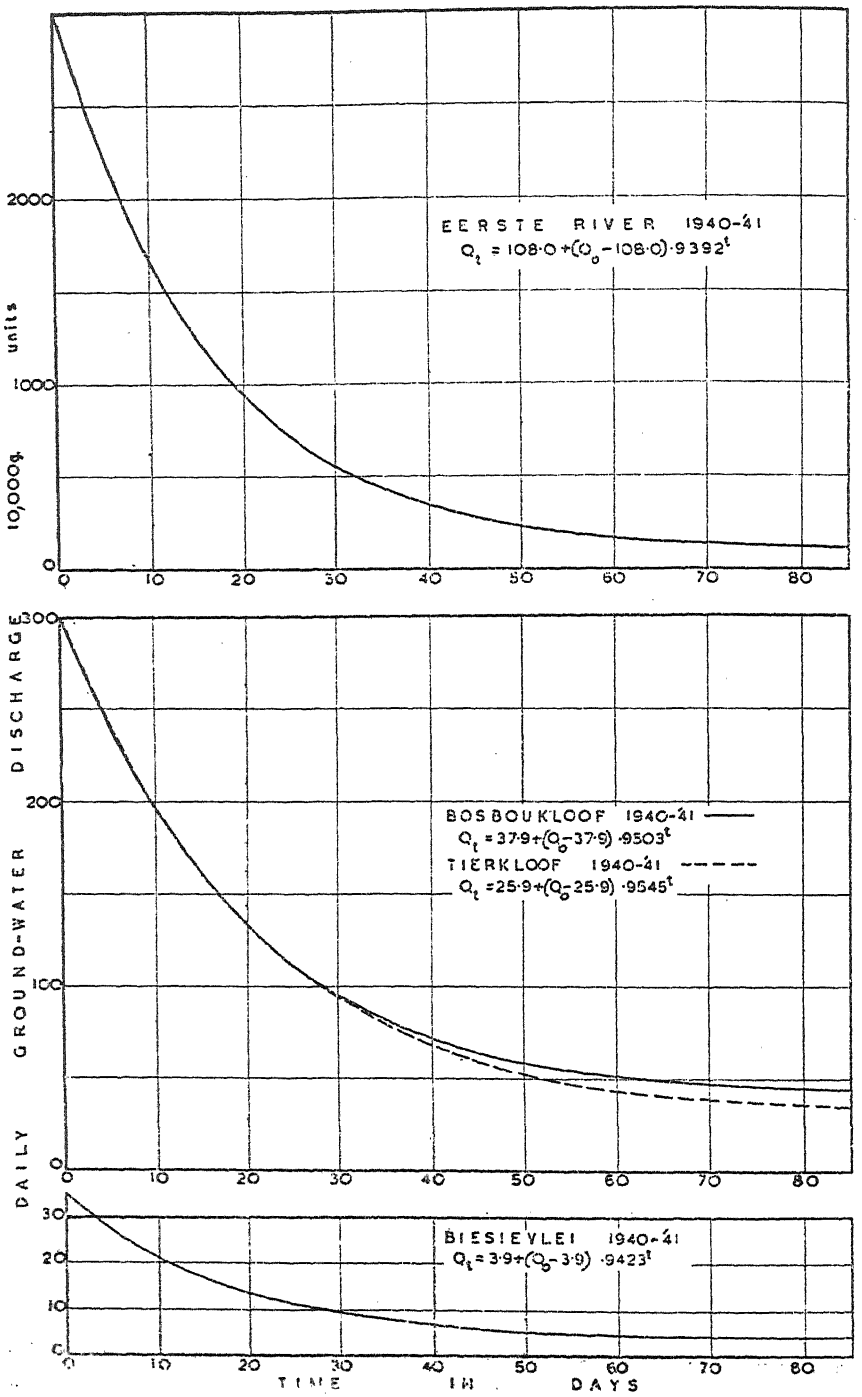


FIG. 3.—Depletion curves for four Jonkershoek streams, 1940-'41.

satisfactorily accounted for so far, although the following discussion will suggest possible explanations for the value *a*.

If the regression functions given in Table I are converted to the form of equation 4, it will be seen that *a* is decreased as the period after spates is lengthened and stormflow is excluded more and more. After five days it remains about constant. This can be ascribed to the tilting of the line to a steeper slope by the abnormally rapid depletion in the high flow classes, caused by delayed stormflow in the stream. The change in slope of the line causes its lower portion to move further away from the zero. The constant *a*, which remains after stormflow has been excluded, may possibly be ascribed to flow derived from very deep seepage, because such a supply may be expected to remain about constant over the relatively short periods of observation. It would in fact be the almost constant flow represented by the almost horizontal portion of depletion curves observed for low values of ground-water flow. In other words the depletion at such low levels is so slow, that with the relatively course grouping of observations into 50,000 gallon classes and the relatively short periods of observation, the flow was recorded as constant though it actually did drop slowly. Further investigations of depletion at low flows with no grouping or with smaller class intervals and possibly with more accurate recordings of flow, should show whether the constant *a* is due to errors caused by using a technique of gauging and method of analysis, which are insufficiently sensitive, or whether it reflects a true feature of ground-water flow. Preliminary computations have shown that *a* can be reduced by decreasing the class interval used in computing a regression function.

TABLE III

VALUES FOR CONSTANTS IN ANNUAL, LINEAR REGRESSIONS FOR 2-DAY DEPLETION PERIOD (EQUATION 4) AND DEPLETION CURVE FUNCTIONS (EQUATION 5).

No readings taken earlier than five days after spates.

Stream	Year	No. Observations	Values in equation			
			4 for		5 for	
			a	b	$\frac{a}{1-b}$	$\sqrt{b}$
Bosboukloof	1938	116	1·375	·937	21·8	·9680
	1939	164	3·616	·860	25·8	·9274
	1940	127	2·013	·901	20·3	·9492
	1941	96	7·139	·888	63·7	·9423
Biesievlei	1940	111	·690	·860	4·9	·9274
	1941	102	·303	·902	3·1	·9498
Tierkloof	1940	107	2·036	·901	20·6	·9492
	1941	89	3·369	·908	36·6	·9529
Eerste River	1940	74	8·936	·874	70·9	·9349
	1941	60	15·998	·897	155·3	·9471
Abdolskloof	1941	140	·054	·959	1·3	·9793

The second constant in the regression function is *b*, the regression coefficient, which may also be called the coefficient of ground-water flow depletion. It indicates the difference in depleted Q for every difference of one unit in initial Q. It is an average value determined from all the observations, and strictly applies only within the range covered. If,

however, the observed value of a is very low or zero the coefficient may be used for extrapolation below and above the values observed. The coefficient fixes the slope of the line and can assume any value between zero and 1. If it were to be zero depletion would be instantaneous. If it were to be 1 no depletion would occur. Provided the period of depletion used for determining this coefficient is held constant, its values will reflect the stability of streamflow. If it has a high value the rate of depletion will be low; if it has a low value the reverse will apply. Two-day depletion period coefficients for Jonkershoek all have values of about ·9. From tables published by Engler, approximate coefficients have been determined for the Swiss streams *Sperbel-* and *Rappengraben* (Engler, '19). These gave values between ·60 and ·65, thus indicating relatively more rapid depletion than at Jonkershoek.

The slope of the regression line must be steeper than 45 degrees to indicate greater depletion from high values of flow than from lower values, as shown by the depletion curve (see Fig. 3). This form of depletion curve is also obtained if the water draining from a tank through a small aperture near its base is recorded. Here the cause of the depletion in flow is the decrease in head as the volume of water in the tank is diminished. If a number of minor influences are ignored, the cause of the depletion of flow from a catchment is the decrease in head of ground-water in storage. Harrold has examined this relation between streamflow and ground-water depletion (Harrold, '34). The decrease in head of ground-water is mainly due to the gravitation of water through the soil, and to evaporation and transpiration losses from the catchment. In a simple phreatic catchment where the ground-water is not directly abstracted by evaporation and transpiration (Horton, '33), the decrease in head of water in storage and consequently the depletion of ground-water flow in streams will depend on two main factors: degree of saturation of the catchment before depletion and resistance to gravitation of moisture in the soils of the catchment. For a given degree of saturation the rate of depletion will depend mainly on the rate at which ground-water will percolate through the particular soils represented in the catchment. Indirectly the coefficient of depletion will, therefore, also indicate the resistance to seepage within the catchment, and a change in the coefficient in any catchment as the result of a change in management should reflect fundamental changes in seepage conditions.

The fact that for Jonkershoek streams (see Table III. and Fig. 2) the coefficient is always about ·9, shows that the resistance to seepage is more or less constant for this region under existing conditions. This is to be expected where soil conditions and vegetation are nearly uniform. Differences in size and topography of the catchments apparently do not affect the coefficient. In a single catchment, where seepage conditions remain relatively constant, the coefficient is also not affected by differences in wetness of the years. This is shown in Fig. 4 and Table III, where linear regressions from *Bosboukloof* for the years 1938 to 1941 have all about the same slope. Rain-gauge No. 1 at Jonkershoek standing next to the *Bosboukloof* stream, recorded 44·47 inches in 1938; 35·94 inches in 1939; 40·98 inches in 1940, and 60·28 inches in 1941.

The small variations in value of coefficients which have been observed are probably due to chance, because as can be seen in Table III, they appear to be unsystematic. They are as great from year to year for one stream as they are between streams. If longer observation periods than one year are used they will probably be reduced.

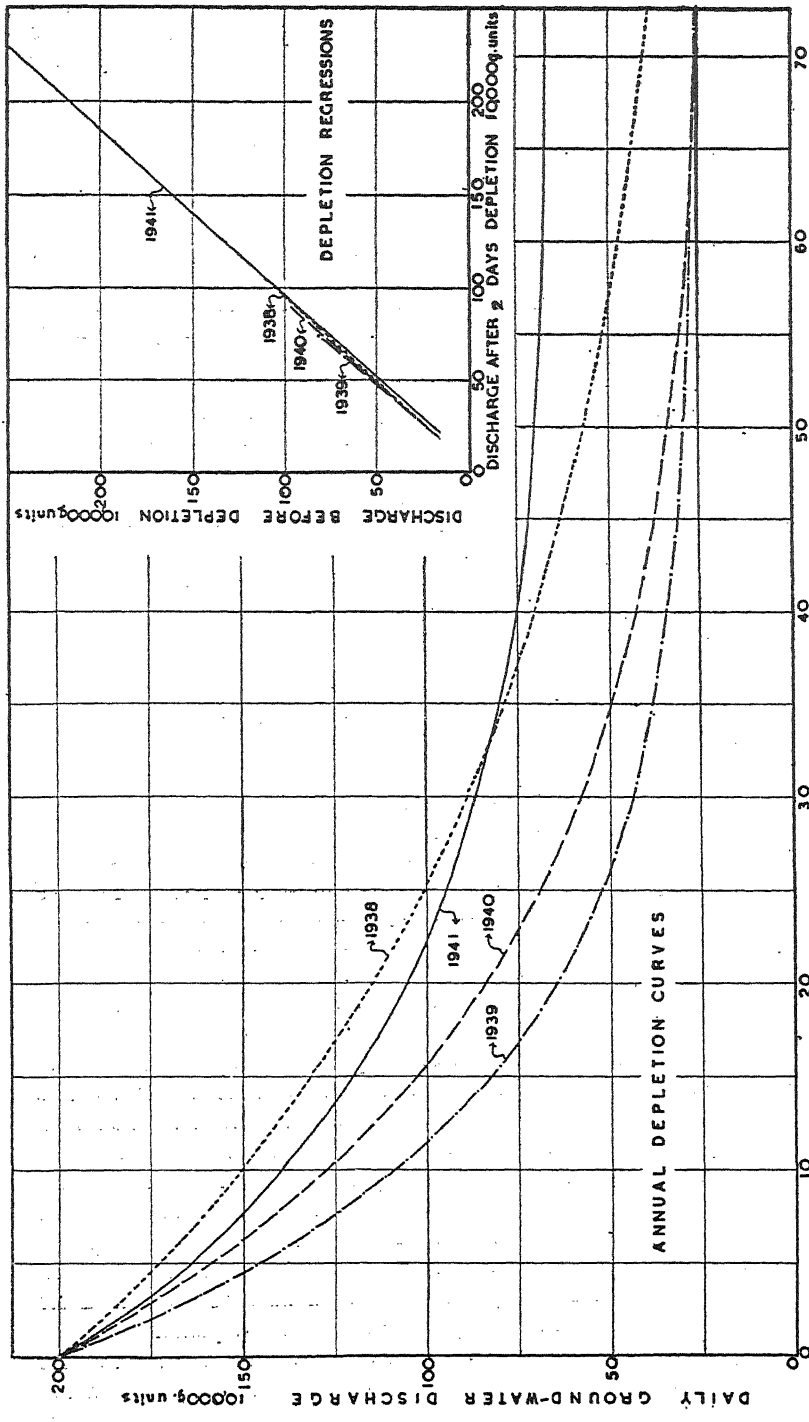


FIG. 4.—Annual regressions and depletion curves. Bosboukloof, 1938-'41.

The depletion curves for *Bosboukloof* and *Tierkloof* reproduced in Fig. 3, show that the *Bosboukloof* stream is slightly more stable than the *Tierkloof* stream. Their coefficients of depletion are, however, very close together. The difference is probably due to the fact that *Tierkloof* is a somewhat steeper, narrower catchment with probably shallower soil, so that conditions for deep seepage are less favourable. Resistance to seepage in the two areas is similar, however, because in both cases the soils are derived from Table Mountain Sandstone overlying granite and the vegetation is similar.

Although the coefficients of depletion regressions for *Bosboukloof*, shown in Table III and Fig. 4, lie close together, the deduced depletion curves show considerable differences. The variations in the constant *a* in the depletion regression functions do not greatly affect the positions of the regressions lines. In the depletion curve equations the variations in the apparently constant base flow affect the form of the curves more markedly, however. In wet years the apparently constant base flow is higher (see Table III), due to more complete saturation of the catchment. Such saturation causes strong replenishment of deep seepage, which leads to a strong, almost constant, base flow (see curve for 1941 in Fig. 4). In drier years slight replenishment of deep seepage causes the stream to drop more rapidly to a lower—apparently constant—base flow (see curves for 1939 and 1940 in Fig. 4). In very dry years no seepage may penetrate to deep levels and the base flow would then depend solely on deep seepage from previous years. In extreme cases no deep seepage will ever reach the stream, and there will then be no maintained base flow. Streamflow will be seasonal under these circumstances. This argument is borne out by the fact that the depletion curves depicted in Fig. 4 would lie close together if the constant *a* were taken equal to zero. When considering these curves it must be remembered, however, that extrapolation has been used. In the years 1939 to 1940 no high ground-water flows were recorded. To account fully for all features of depletion curves other factors such as duration and intensity of rainfall would also have to be considered. The main differences appear to be due to variations in deep seepage depending on differences in wetness of the years, by which the magnitude of the apparently constant base flow is affected. For these reasons it would be better in future to compute annual regressions and depletion curves for the streamflow year, which, at Jonkershoek, commences with the first winter rains in April.

Because the depletion curves are strongly affected by the wetness of the years in this way, the rainfall factor will have to be taken into consideration if they are to be used to demonstrate the effects of catchment treatment on ground-water flow. One way of doing his would be to assume a fixed value for initial Q, for example 200 units for *Bosboukloof*, and then estimating—according to the depletion curves—the annual volumes of ground-water flow that would be delivered in a fixed period of say 100 days. The regressions of estimated volumes of ground-water discharge on rainfall totals for the streamflow years could then be used as criteria for judging the effects of treatment on ground-water flow depletion.

The very valuable assistance and advice received from Professor J. T. Morrison, in connection with the derivation of the depletion curve equation from the linear regression function, are gratefully acknowledged.

SUMMARY

A preliminary study of ground-water flow from small, natural, untreated catchments at the Jonkershoek Forest Influences Research Station is presented. This investigation is intended ultimately to provide a criterion for the assessment of the effect of afforestation, veld-burning, grazing and protection of natural vegetation upon the stability of streamflow.

It is shown that the regression of ground-water flow after a unit period of depletion on flow at the beginning of that period is linear. From this regression an equation for constructing ground-water depletion curves is derived.

The coefficient of the linear regression of ground-water flow depletion, the regression function and the depletion curve equation are suggested as suitable statistics to be used to demonstrate the effects of catchment management on ground-water flow in streams. Finally, the hydrological interpretation of these statistics is discussed.

REFERENCES

BURGER, H.: Einfluss des Waldes auf den Stand der Gewässer. II. Mitteilung. Der Wasserhaushalt im Sperbel- und Kappengraben von 1915-16 bis 1926/27. Mitt. d. Schweiz. *Anstalt f.d. forstyl. Versuchswesen.* 18: No. 2—311-416. Zürich, 1934.

ENGLER, A.: Einfluss des Waldes auf den Stand der Gewässer. Mittl. d. Schweiz. *Zentralanstalt. f.d. forstl. Versuchswesen.* 12: Zürich. 1919.

FISHER, R. A.: Statistical Methods for Research Workers. Oliver and Boyd. London. 1936.

FISHER, R.A. & YATES, F.: Statistical Tables for Biological, Agricultural and Medical Research. Oliver and Boyd. Edinburgh. 1938.

HARROLD, L. L.: Relation of Streamflow to Ground-Water Levels. *Trans. Am. Geophys. Union.* 15th Annual Meeting. P.414. 1934.

HORTON, R. E.: The Role of Infiltration in the Hydrologic Cycle. *Trans. Am. Geophy. Union.* 14th Annual Meeting. P.446. 1933.

————: Surface Run-off Phenomena. Part I. Analysis of the Hydrograph. Publ. No. 101. Horton Hydrological Laboratory. Voorheesville, New York, 1935.

HOYT, W. G., & OTHERS: Studies of Relations of Rainfall and Run-off in the United States. Water Supply Paper No. 772. U.S. Dept. of the Interior. Wash. D.C. 1936.

IWASAKI, T.: A Streamflow Study of the Tokyo Water Supply. *J. Am. Water Works Assoc.*, 26: No. 2, 163-175. 1934.

MEAD, D. W.: Hydrology. McGraw-Hill Book Co., New York, 1919.

SCHAFFERNAK, F.: Hydrographie. Julius Springer. Vienna. 1935.

TRANSACTIONS AM. GEOPHYS. UNION. 16th An. Meet. Report of the Comm. on Rainfall and Run-off. 1934-35. L. K. Sherman, Chairman, Appendix: D.P.419. 1935.

WICHT, C. L.: Forest Influences Research Technique at Jonkershoek. *J. of the S.A. For. Assoc.* 3:65-80. 1939.

————: A Preliminary Account of Rainfall in Jonkershoek. *Trans. of the Royal Soc. of S.A.* 28:161-173. 1940.

————: Diurnal Fluctuations in Jonkershoek Streams due to Evaporation and Transpiration. *J. of the S.A. For. Assoc.* 7:34-49. 1941.

RODENT DAMAGE IN PLANTATIONS AND ITS PREVENTION

By D. H. S. DAVIS

(Ecologist and Chief Rodent Officer, Union Health Department.)

DURING the last twenty years large areas of grassland have been enclosed by Government for afforestation. Grass-veld freed thus from the effects of grazing and cultivation has developed unchecked and attained a luxuriance not reached before. Grass-living field rodents, especially striped mice and vlei rats, for whom cover is a prime necessity, have thus found their available habitat vastly increased. Both have been convicted of ring-barking the stems and branches of young trees, but the vlei rat appears to be responsible for the worst damage. Damage has taken place on a larger and larger scale with the passage of the years until in some areas it ranks as one of the most serious menaces to the production of well-stocked young plantations and the question of control is now urgent.

Vole Damage in Great Britain.

The British Forestry Commission has experienced similar damage to young coniferous plantations, particularly on former sheep pastures. Here a field mouse—the short-tailed vole *(Microtus agrestis)*—with habits and conditions of life rather similar to the vlei rat, is responsible. With enclosure of land for afforestation the vole population multiplied and damage became a regularly recurring feature of young plantations in Great Britain. Elton (1), writing on the multiplication of voles following enclosure for afforestation and the resulting protection of grassland from stock and fire, states: "When hill pasture is drained and fenced off for planting, the grass and rushes soon develop a luxuriance that is quite surprising to see, and which makes one realise the dynamic equilibrium in which this vegetation has previously been held by sheep and cattle . . . This huge State project [The Forestry Commission planting programme] has unintentionally increased the average vole population of this country [Great Britain] by many million individuals and provided an ideal setting for the study of vole fluctuations and epidemiology. These fluctuations have also an important repercussion on the planting programme, because voles often seriously damage young trees. The district most subject to damage is Argyll where nearly a million young conifers were destroyed by ring-barking in the winter of 1929-30 alone. Here there was further serious destruction in 1932-3, 1935-6, and 1937-8. But damage of this nature occurs widely on a lesser scale in many forests." The damage years, referred to by Elton, reflect what is one of the most striking features of vole populations in the northern hemisphere, namely their well-marked 3-4 year cycle in population density. Damage is naturally worst at the time of greatest abundance and virtually ceases during the years when the voles are increasing towards the next peak in numbers.



PLATE I.—The vlei rat *(Otomys irroratus)*.

Photo: D. H. S. Davis.

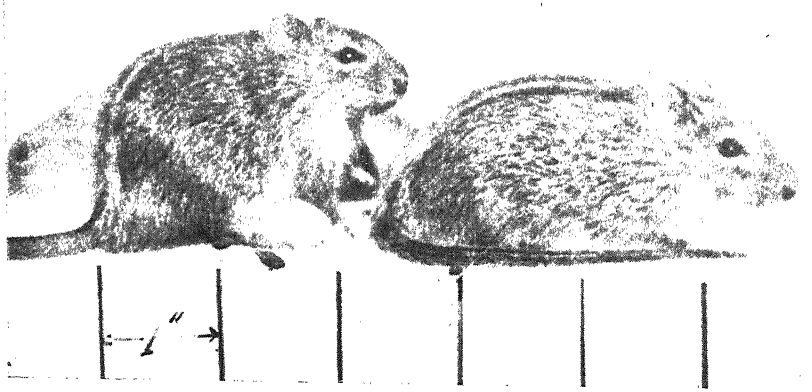


PLATE II.—The striped field mouse *(Rhabdomys pumilio)*.

Photo: D. H. S. Davis.

Population Fluctuation and Disease.

The rather sudden decrease which marks the end of a period of increase of a wild rodent population is often brought about by the outbreak of disease. So far there is no indication that grass-living rodents in South Africa exhibit a population cycle, but it may well be that one exists and will become apparent in years to come. Short-period fluctuations exist among other South African rodents. Multimammate mice *(Mastomys)* have periodically become a pest in Zululand and "plagues" of them have recurred fairly regularly. Plague-carrying gerbils *(Tatera)* also show marked fluctuations in numbers (2), but no detailed analysis has yet been made. Sudden disappearance of vlei rats from diseases other than plague is known but records are few. They died in some numbers at the Wilderness, Cape Province, from an unknown cause in 1939 and Roberts (5) in Kenya reported an epizootic near Nairobi in 1931 when vlei rats died off under circumstances strongly suggestive of plague. Intensive investigation ruled out plague, but could not establish the cause of the disease.

Vlei rats act as reservoirs of plague in the Orange Free State. The possibility of plague reaching forest areas in centres of high vlei rat population is not out of the question.

Vlei Rats and Plague.

In South Africa plague is maintained by wild rodents whence domestic rodents and man become infected. The chief reservoir is the gerbil *(Tatera)* but vlei rates in endemic areas sometimes form a secondary reservoir of infection. In the Orange Free State, where plague is worst, vlei rats are found only in small numbers in favourable localities and their multiplication on a scale found in the moister forest grasslands is impossible. Striped mice became infected at Knysna in 1903 when plague was rife in the ports (3), but the focus of infection died out. They play a minor part in plague epizootics.

The eastern boundary of plague in the Transvaal and Orange Free State follows roughly the 30" rainfall contour. From Marico the eastern limit of human outbreaks runs southwards through Krugersdorp to the south of Johannesburg, crosses the Vaal River east of Vereeniging, passes east of Heilbron through Lindley, Senekal and Ladybrand to Wepener and on into the Transkei. The endemic area does not extend from the karoo across the Langebergen, Zwartbergen or Hex River mountain ranges to the coastal areas. All, therefore, but the Eastern and Transkeian Conservancies are virtually out of contact with endemic plague. Nevertheless epizootics amongst gerbils have taken place in parts of Natal in the Pietermaritzburg Forestal District, but no evidence that they were caused by plague has ever been obtained. In the Transkei plague appears to be spreading eastward from the Glen Grey district. St. Marks district was reached in 1938 and at the time of writing there were outbreaks in the Glen Grey and Queenstown districts with some suggestion that plague was present among rodents further east still.

The material upon which this article is based, so far as rodent damage to forest plantations is concerned, derives from a short visit to the Pietermaritzburg Forestal District in June, 1941, from seventeen reports from foresters sent in reply to a questionnaire issued by the Division of Forestry and from other information furnished by forest officers.

The Rodents Responsible for Tree Damage.

Consensus of opinion indicts the vlei rat as the worst offender, with striped mice second. The exact status of each as damaging agents is not, however, settled and for practical purposes the vlei rat is the one to contend with, for measures against it are equally effective against striped mice. Other grass- and scrub-living rodents such as the tree-mice *Dendromus* and *Psammomys* may also play a part.

" Vlei rat " describes best the animal known scientifically as *Otomys irroratus* (see Plate I). It is known also as Vlei Otomys, water rat, gras rot, i-bunzi (Zululand), igunqu (Transkei), field rat and field vole. They are " robust rats with short legs and tails, the latter with numerous bristles not hiding the scaly rings, and never as long as head and body, skull short and broad. The upper incisors broad and . . . grooved, . . . the Vlei Otomys . . . is distributed over the moister areas . . . They are diurnal in habits, sheltering in nests made in the dense marshy vegetation or in shallow holes, and making runways from these through the grass or weeds in the neighbourhood. When they occur they are usually plentiful, and to some extent sociable " (4).

Striped mice *(Rhabdomys pumilio)* (see Plate II) are more widely distributed than vlei rats. They also range over a wider number of habitats. They are primarily seed eaters, but also feed upon grass stems and other plants. Their runways, which they make amongst grass, are less well defined than those of vlei rats. but each uses the others'. Striped mice shred grass fine to make a nest, whereas vlei rats use it unshredded. Both nest in grass tussocks, as well as in shallow holes in the ground and other places and are active during the day and parts of the night. Vlei rats live almost entirely on the stems and roots of coarse grasses and short lengths of grass may often be seen lying in their runways. Being active during the day both need some measure of cover to protect them from enemies.

From the experience I have had it appears that during the summer when vegetation is green and luxuriant vlei rats are more widely scattered than in the winter when the thicker vegetation is scarcer. Winter, the damage season in summer rainfall areas, may see them somewhat more concentrated in plantations. Concentration, together with a shortage of green food may therefore aggravate the apparent need for tree bark and may again account for the damage being done in localised patches—a feature that stands out clearly. Much further field work is required before an understanding of even the broader points of vlei rat ecology can be reached.

Tree Damage.

Both conifers and broadleaved species are attacked, but as nine out of ten trees now planted on State forests are pines, attack on them is naturally most commonly reported. Wattles and gums appear to be almost free. Few if any coniferous species have not been attacked at one or other time and place. In the following list of species attacked, in order to indicate broadly the geographical distribution, the forestal districts in which damage is known by the writer to have taken place are included.

Pinus caribaea (Sabie, Nelspruit, Pietermaritzburg, Butterworth, Stormsrivier and Knysna).



PLATE III.—A wind-fallen ring-barked *Pinus caribaea* stem planted in mature, undisturbed grass-veld at Weza, Natal.

Photo: D. H. S. Davis.



PLATE IV.—*Cupressus lusitancia*. Bark peeled stem and laterals to a height of some three feet. Border, Natal.

Photo: D. H. S. Davis.



PLATE V.—Rank vegetation in four-year-old plantation of *P. caribaea,* Middlebrook, Natal. Eighty per cent. of the trees damaged.

Photo: D. H. S. Davis.

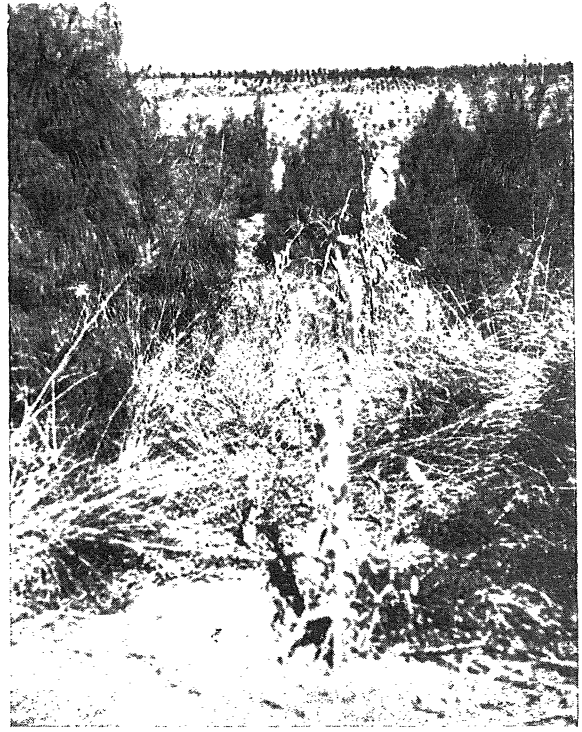


PLATE VI.—Mealie cultivation between tree rows at Sarnia, Natal. Compare patchy distribution in background with freedom from damage amongst trees in foreground alternating with lines of mealies.

Photo: D. H. S. Davis.

P. patula (Nelspruit, Pietermaritzburg, Butterworth, Keiskama Hoek and Knysna).
P. taeda (Pietermaritzburg, Butterworth, Keiskama Hoek and Knysna).
P. longifolia (Pietermaritzburg, Butterworth and Stutterheim).
P. canariensis, P. pinaster, P. montezumae (Butterworth).
P. insignis (Keiskama Hoek).
P. khasya, P. palustris (Nelspruit).
Cupressus spp. (Sabie, Nelspruit, Pietermaritzburg and Butterworth).
Cryptomeria japonica (Pietermaritzburg).
Sequoia sempervirens, Taxodium distichum, Liriodendron tulipifera and *Gmelina arborea* (Butterworth).
Cedrus deodara (Pietermaritzburg and Butterworth).
Oak (Stutterheim).
Poplar (Pietermaritzburg and Stutterheim).
Willow *(Salix babylonica)* (Pietermaritzburg).
Gum *(Eucalyptus saligna)* (Butterworth).

Although no reports on rodent damage have been received from Western Conservancy areas, other sources of information suggest that little or no damage is done to trees there. The region throughout which damage has taken place on a large enough scale to become a problem embraces broadly the forest areas from Knysna northwards to the Transvaal lowveld. Here *P. caribaea* and *P. patula* are the two species of greatest economic importance and are the most commonly planted. *P. caribaea* seems to have suffered somewhat greater damage than *P. patula* probably because it can be planted in wetter conditions, where vlei rat damage can be expected first. *Cupressus* suffers very severely and seems to be especially attractive. There is some suggestion that *P. pinaster* and *P. insignis* are less liable to attack though they are not widely planted within the areas most subject to damage.

Ring-barking is not the only kind of damage. In both pines and cypresses extensive gnawing is done to the lateral branches, sometimes to a height of three feet or more (see Plates III and IV). Both vlei rats and striped mice have been observed in the act of barking trees in the daytime and fresh damage observed early in the morning suggests that it is also done during the night. There appears to be no selection of particular trees in a stand though the occurrence of localised patches of damage suggests a preference for certain combinations of conditions. What these conditions are, is not clear. Further investigation is needed to bring out the relations between the number (population density) of rodents in a particular area, the ecological composition of the grasses and the incidence of damage.

In summer rainfall areas damage takes place in winter. In the Pietermaritzburg Forestal District it has become progressively earlier in the winter, and now takes place as early as the end of March, as against July and August formerly. Damage ends as soon as the first summer rains bring on a growth in the grass.

Damage becomes more general with the progressive expansion of the rodent populations in the maturing grassland of an area being afforested for the first time. Damage on a large scale is a comparatively recent phenomenon. Initial plantings show little sign of past rodent damage, later plantings bear some scars and the most recent show the signs of general attack. It remains to be seen how long this population increase can go on. It may be, as has been suggested in the first part of this

article, that a disease will break out to reduce the high population density and that years of rodent abundance and scarcity will be experienced in the future.

Damage can, of course, take place only when rodents are actually living in the grass amongst the trees. The formation of a canopy and the gradual suppression of the vegetation brings their period of occupation to an end. Different species of trees suppress the grass at different rates, but generally speaking rodents leave the plantations within five to seven years after initiation. The trees themselves, by their growth, thus automatically rid a plantation of grass-living rodents by suppressing the underlying vegetation. The aim of control is to do somewhat the same thing: so to disorganise the grass-cover that it can no longer give the rodents that protection from weather and enemies which is vital to the meeting of their feeding and reproductive needs.

Control.

Poisoning has not been effective enough to be recommended. It is also hazardous to the rats' natural enemies such as hawks, buzzards, cranes, owls, mongooses, polecats and even jackals whose preservation should be of concern to every forester and farmer. Trapping, though like poisoning, sometimes effective on small areas, is of no value amongst extensive plantings. Poison and traps to be effective would have to be distributed on such a scale that the cost would be prohibitive. Even then these methods of direct destruction have only a temporary effect, for by natural increase and immigration a rodent population can, in a very short time, regain its numbers.

There is no doubt that, as learnt from bitter experience in some of the worst hit forest areas, the removal of grass-cover is the best and most certain protective measure. By means of cover- or habitat-control grass-living rodents are deprived of their accustomed surroundings. Their elaborate run-systems, over which they move from one nest, refuge or feeding place to another in their daily round of activity, are destroyed. Protection from the sun, wind and rain and from enemies is done away with. The disappearance of sheltered runways, nests and well-known landmarks causes confusion, exposes them more to their enemies and forces them to migrate or perish.

The most intense form of weeding, i.e. *clean-skoffeling* (hoeing) gives the best results and is at the same time a regular silvicultural measure of direct benefit to the trees. Almost every silvicultural operation from the time of planting to the final suppression of the vegetation by canopy formation contributes to a greater or lesser extent towards the control of rodents.

Planting in mature grass-veld with no preparation at all (trowel-planting) or in prepared pits, leaves the matted tussocky grass as it was and in most cases not amenable to clean-skoffeling. Preparation of the ground by ploughing and harrowing or by picking, after the area has been burnt over, destroys the grass tussocks and makes clean-skoffeling possible. In potential vlei rat grassland clearly the latter, more expensive method of preparation gives a better chance of subsequent rodent control. *Burning* temporarily makes the area unfit for colonisation by rodents. In the process some are no doubt killed, while others are driven off to seek shelter nearby and may meet with hostile colonies (gerbils, for instance, kill others introduced into their colonies). The burnt area will be

re-colonised lightly as the grass grows but annual burning apparently does not permit very heavy infestation as a rule. *Ploughing* and *harrowing* break up the grass tussocks so that subsequent growth does not develop so dense a mat, and the vegetal cover is more easily controlled. It has already been mentioned that to keep cover down to a point at which rodents will not remain, clean-skoffeling is the best method of *weeding*. Pit-skoffeling clears the vegetation from the base of the trees but does not destroy other cover, while slashing does away with surface growth but does not get rid of the tussocks. Neither of these methods of weeding is fully effective. If the grass can be removed after skoffeling or slashing so much the better, but leaving it piled between the trees is better than letting it lie where it was cut.

The growing of mealies between the tree rows is carried out by native women in some plantations in Natal. Cultivation keeps down the grass and the end of cover-control is served cheaply. In Plate VI mealies are seen growing between the rows. On the distant slopes where no cultivation was done gaps can be seen whereas in the cultivated part the trees suffered no damage. An extension of such cultivation where the soil is suitable is a small but important contribution to the general problem of safeguarding young trees from the depredations of rodents.

Acknowledgments

In concluding what can only be at the present state of knowledge and experience of rodent damage a sketch of the general problem I should like to express my gratitude to those who have supplied me with informations, particularly to Mr. H. B. Stephens, Conservator of Forests for Natal and the Orange Free State, and Mr. C. H. Clayton and the Foresters in Natal who gave me first-hand information of conditions in the Pietermaritzburg Forestal District; to Mr. N. L. King and Mr. W. E. Watt for much valuable information on silvicultural practice and on their experience of damage, and finally to those Forest Officers and Foresters who through replies to a questionnaire circulated by the Division of Forestry put their knowledge of rodent damage at my disposal.

References

1. Elton, C.: Voles, mice and lemmings. Problems in population dynamics. Oxford, 1942. Page 176.
2. Fourie, L.: The endemic focus of plague. *Med. J. S. Afr.* 12:352-357, 1938.
3. Mitchell, A.: Plague in South Africa: historical summary. Pub. S. Afr. Inst. Med. Res. 3:89-108, 1927.
4. Roberts, A.: Mammals concerned in the bubonic plague and rabies problems in South Africa. *S. Afr. J. Sci.* 32:414-460, 1935.
5. Roberts, J. I.: The relationship of field rodents to plague in Kenya. *J. Hyg., Camb.* 39:334-343, 1939.

TIMBER SEASONING IN SOUTH AFRICA

By M. H. SCOTT

(Senior Forest Products Officer, Division of Forestry.)

IT is now twenty years since the first scientific experiments on the seasoning of indigenous timbers were commenced by the Forest Department working in co-operation with the Railway Administration in the Pretoria Railway Workshops. At that time South African timbers generally possessed a bad reputation due largely to faulty conversion and poor seasoning methods. Many South African woods were, of course, well known for their excellent qualities once they had been seasoned, but very little was known about the principle involved in the practice of seasoning, and the wastage in conversion due to this and other causes was very considerable. In many cases the methods practised were based on tradition and there are even to-day many sawyers who would under no circumstances saw up a tree when the moon is full.

During the first few years excellent results were obtained by kiln drying a number of species green from the saw, and it was for some time thought that this was the only method which would give entirely satisfactory results. As the experimental work progressed, however, it became apparent that the process could be materially cheapened in most cases, without sacrificing efficiency, by a judicious combination of air and kiln seasoning.

The experiments were later extended to locally grown exotic timbers which have assumed very great importance in the economy of the country, the round volume of pine logs yielded during the past year from Government plantations alone being 6,785,000 c. ft. Data has been accumulated for all the better known timbers and a great number of lesser known species in the Union.

Although some of the information obtained has been published from time to time (1 to 8) it has been felt for a long time that the data accumulated up to date might well be put together in the form of a pamphlet for the benefit of those interested in utilising timber from their own wood lots as well as of sawyers, timber merchants and others who may wish to put their products on the market in a thoroughly seasoned condition.

Further specific information on any points raised in this paper if available will gladly be given on application to the Chief Forest Products Officer, Forest Products Institute, Pretoria West, and interested parties will be made welcome should they wish to visit the Institute and discuss their particular problems or to see for themselves the methods employed.

Fundamental Principles

Wood Structure.

In order to appreciate more fully some of the difficulties encountered and the reason for the behaviour of wood while seasoning, it is helpful to know a few simple facts about the structure of timber.

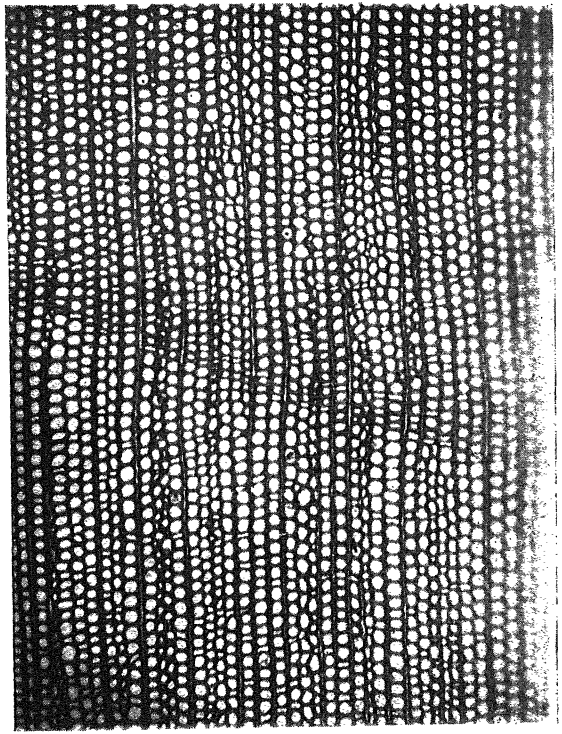


PLATE 1.—Transverse section of yellowwood (X 40) illustrating comparatively simple structure of softwood timber.



PLATE II.—Transverse section of a hardwood timber (red els) (X 40). Compare differentiation of elements with the simple structure of a softwood as seen in Plate I.

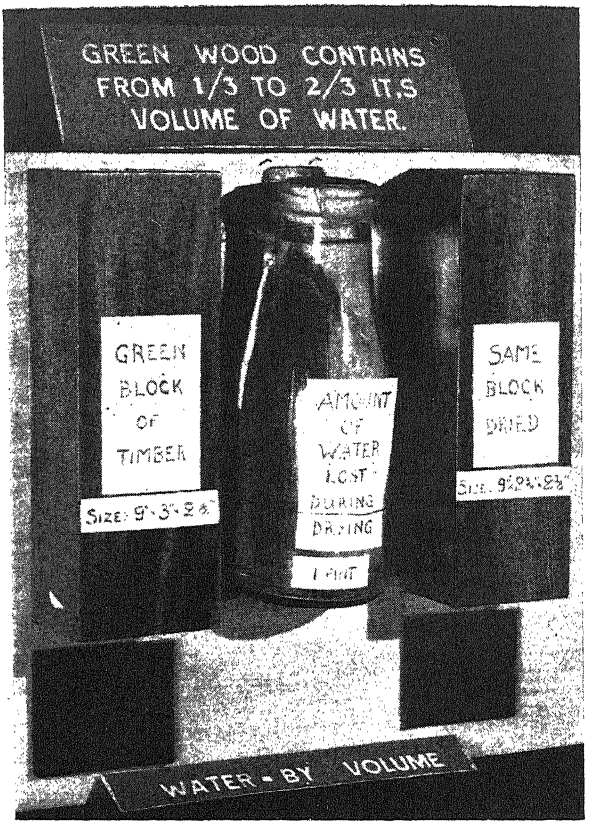


PLATE III.—Volume of water lost and reduction in volume effected in drying a block of stinkwood from green to air-dry condition.

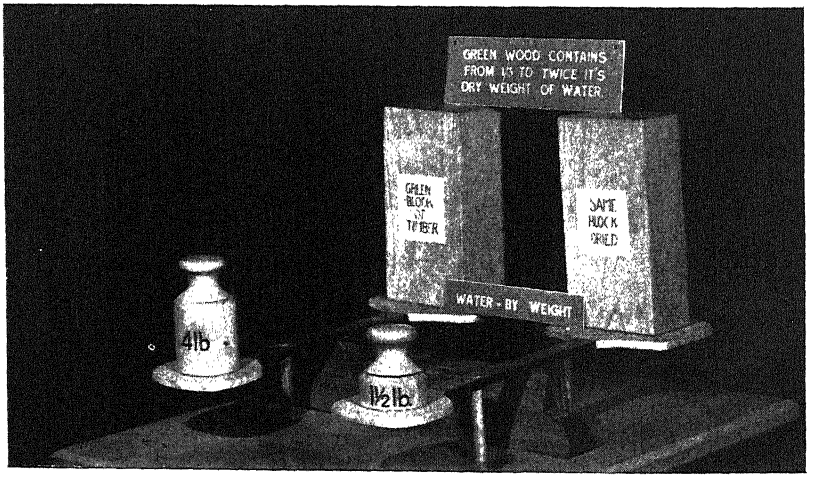


PLATE IV.—Reduction in weight effected in drying patula from green to air-dry condition.

Wood is by no means a homogeneous substance. It consists of a number of different types of cell, each with its particular form and functions. The conifers, or so-called softwoods, are comparatively simple in structure, and are therefore usually more easily dried than the hardwoods. They consist mainly of two types of cell: long narrow vertical cells or tracheids, and groups of short brick-like cells, the rays, radiating from the centre of the tree to the periphery. If a clean transverse cut be made with a sharp knife on the end of a piece of softwood timber and the surface examined through a lens of ten magnifications or more, the tracheids, which give strength to the stem, will be seen as minute rectangular or oblong cells more or less regularly arranged in rows and separated at short intervals by radial lines of ray cells. The latter are the storage and distributing tissue.

In the hardwood class of timber the main feature in a similarly prepared section is a number of much larger pores, known as vessels. These may be seen in many cases without the aid of a lens and are useful as a means of distinguishing between softwood and hardwood timbers. In addition to the vessels, the ray cells, appearing as lines of varying width, usually much wider than in the softwoods, will also be seen. The tracheids and other cells which make up the remainder of the wood tissue in which the pores in hardwoods are set are too small and their walls usually too thick to be individually seen even with a lens.

It is these thick walled tracheids and fibres which, in spite of the associated larger vessels, give the greater strength and weight to the hardwoods. They are responsible for much of the difficulty experienced in drying hardwoods. (See Plates I and II.)

In both classes of wood the rays, tracheids and vessels are interconnected by minute perforations in the radial dividing walls, known as pits, which close as the wood becomes older and thus still further increase the difficulty of extracting the moisture from the cell cavities.

Moisture in Wood.

The wood in a living tree or in a freshly felled log may contain up to four times its own dry weight of water, although in the majority of timbers the weight of wood and water present is about equal. The amount of moisture in wood is always expressed as a percentage of its oven dry weight. Thus *Cryptomeria japonica*, a very light and soft exotic, grown to some extent in the Union, was on one occasion found to have a moisture content in the sapwood as high as 446 per cent. The average green moisture content of young stems of the well-known *Pinus patula* is slightly over 200 per cent., while some of the heavier and older softwoods such as *Pinus pinaster* contain 90 per cent. in the sapwood and only about 30 in the heartwood. Plates III and IV illustrate in a striking manner the amount of water commonly contained in green wood.

Eucalypts, on the other hand, have a fairly even distribution of moisture varying from 60 per cent. in the heavy class such as Karri to 120 in the lighter Saligna. Of the indigenous woods, Sneezewood and Tambotie, both very heavy woods, usually contain only 30 per cent. moisture. The figure for Kiaat is 75, while light woods such as Corkwood run to 120 and more. The heavier woods usually have less

air space within the cell structure than the lighter ones and, accordingly, contain a lower percentage of moisture, though the absolute volume may be much the same. Many local woods when green sink in water, thus making their conveyance in this medium, had it been otherwise practicable, for this reason alone, difficult if not impossible.

Tests carried out throughout the year indicate that there is no significant change in the moisture content of logs with the seasons.

Moisture is present in green wood in two forms. Most of it is free water within the cell cavities and about 25 to 30 per cent. in the cell walls which is known as combined water. Before wood can be used with satisfactory results for practically any purpose all the free water, and about two-thirds of the combined water, must be removed. The most accurate method of determining the moisture content of wood, especially when high, is the gravimetric. For this purpose a drying oven maintained at a constant temperature just above the boiling point of water and an accurate scale are required. Representative sample boards having been selected, test sections are taken not less than one foot from the end of the boards. These sections should be from $\frac{1}{2}''$ to $\frac{3}{4}''$ thick in the direction of the grain and should include the full cross section. The test piece should be weighed immediately after cutting (WW) and then dried in the oven until no further loss of weight occurs (DW). The percentage moisture content is then determined by the formula:

$$\text{M.C. per cent.} = \frac{\text{WW} - \text{DW}}{\text{DW}} \times 100.$$

A second method which is much quicker and where no calculations are required is by means of an electrical moisture meter. These instruments cost from £15 to £30 and are widely used in commercial practice overseas. This type of meter and its method of operation have been described in a previous publication (9). Although not so precise as the gravimetric this method is quicker and is sufficiently accurate for most general purposes, particularly in sorting out seasoned from unseasoned wood. Except in thick dimensions no sawing or cutting of the timber to be tested is required. Any intelligent person can learn to operate it in half an hour or so. The use of the instrument on green timber is strictly limited, and calibration for each species tested is necessary.

Shrinkage.

The removal of this water without injury to the timber would be comparatively simple were it not that shrinkage occurs during the process and since it is very difficult to dry boards evenly throughout their thickness uneven shrinkage occurs, which may result in warping, twisting, and cracking of their surfaces and ends. In addition to the difference in shrinkage in different parts of the boards due to uneven drying, the various woody elements shrink in various directions. While in the radial plane the rays check contraction of the tracheids and other elements, on tangential surfaces they shrink with the tracheids. The result is that the radial shrinkage is less than that of tangential, usually about half. Except in special cases the amount of longitudinal shrinkage in wood is fortunately negligible. The figures in Table I indicate the relative amount of shrinkage to be expected in drying boards from a green to an air dry condition suitable for general use. Unlike moisture content, the extent of shrinkage is based on the size of the wood wet.

TABLE I.

RELATIVE SHRINKAGE IN AIR DRYING OF SEVEN SPECIES.

Species.	Shrinkage in % of green size.		
	Tangenital.	Radial.	Longitudinal.
Karri	9·00	5·40	·17
Saligna	8·00	4·40	·17
Stinkwood	8·00	4·20	·12
Yellowwood	4·40	2·80	·07
Pinus insignis	4·40	2·40	·13
Pinus patula	4·00	2·70	·09
Kiaat	2.10	1·50	·08

It should be noted that shrinkage occurs only when the combined water or water in the cell walls themselves is removed and therefore nearly all the shrinkage happens in the latter stages of drying, when the moisture content falls below about 30 per cent. and is more or less inversely proportional to the latter. From this the importance of drying wood to the correct final moisture content can be seen. Some of the difficulties caused by the more rapid drying of the outer surfaces of boards are dealt with later.

As wood is hygroscopic, the amount of moisture present in any piece, and consequently its shrinkage, will vary with the humidity of the surrounding atmosphere. Absolutely dry wood, except in an oven, does not exist. Tests made over several years in eight representative centres of the Union, on samples of timber exposed to the atmosphere without actually coming into contact with rain or sun rays indicated an average equilibrium moisture content for the Union of 10·4 per cent. In the moister coastal parts the figure rose as high as 13·7, while for dry high veld conditions such as at Bloemfontein it was 7·8. A variation of 1 per cent. on each side of the mean covered the difference occurring between species. Subsequent recent tests confirmed these figures. In buildings heated during the winter the moisture content was found to fall as low as 6.

PURPOSE OF SEASONING

The definition of seasoned timber which is now being considered by the South African Standards Association is worded as follows:

" Seasoned timber is air dried or kiln dried timber, the moisture content of which is in approximate equilibrium with the atmospheric conditions where used."

When the moisture content of the wood is reduced to this stage, generally known as the equilibrium moisture content (EMC), subsequent movement will be reduced to an extent that in most cases will be comparatively harmless. This may be regarded as the main purpose of seasoning.

Other important reasons for seasoning timber, especially in South Africa, are *to reduce the weight of the product.* This is especially important where distant cartage or railage has to be undertaken. From what has been said it can be seen that the weight of green patula, for instance, is two to three times the weight of the dry wood.

To prevent discolouration. Not only with our fast grown pines which contain a very high proportion of sapwood, but also with many of

our indigenous woods, discolouration or blueing develops if the woods are not dried out as soon as possible after the trees have been felled. The protection offered by anti-stain solutions does not last for more that a few months, and these solutions are of little effect if the timber is not immediately open stacked to dry out.

To increase durability. Wood destroying fungi require for their existence a minimum amount of moisture of about 22 per cent. in the wood. Dry wood, i.e., wood with a moisture content below 20 per cent., therefore cannot rot.

Strength, paintability and *workability* of wood are moreover enhanced and preservative treatment facilitated by the process.

Air Seasoning

Season for Felling.

As seasoning may be said to commence at the time the trees are cut in the forest the time of year at which felling is undertaken deserves some consideration, particularly if the timber is to be air dried. The best time for felling is generally regarded as late summer or winter and there are several good reasons for this if the timber is to be air dried. The sapwood of most hardwood species, particularly in partially dry wood, is liable to attack by borer and the seasoning period is an ideal time from the borers' point of view. Still, quiet places where there is not too much bright sunlight and where eggs may be laid in the numerous crevices and the pores of the wood which have been cut across, are just what they want. Fortunately, they are less active in winter than in summer and by the time the dormant period is over the timber may be sufficiently dry for the next stage in its manufacture.

Hot dry summer weather tends to dry freshly felled boards too quickly from the surface, resulting in stresses due to uneven shrinkage which is the cause of much degrade. This applies especially to hardwoods.

During the winter months drying conditions in winter rainfall regions are much less severe. In the summer rainfall area discolouration due to blueing or moulding in winter-felled pine timber can be largely avoided by proper stacking, whereas in the wet season it is difficult to obtain satisfactory drying at all.

If timber is to be kiln dried directly from the saw the time of year at which the logs are cut is immaterial and in any case sawmills of a necessity have to keep working the whole year round. Blueing can be prevented by dipping and rate of drying controlled by depth of stickers and other expedients. Beetle attack is prevented in hardwoods either by removing as much sapwood as possible or by treatment in zinc chloride or other preservatives as soon as the sapwood is dry enough to absorb the required amount of solution.

Breaking Down of Logs.

From every point of view rapid conversion of the round log to the sawn board is advised. Logs should never be left in the round longer than is necessary and should be cut as long as convenient for milling purposes.

Softwoods blue rapidly in the log, and if once discoloured the dipping of boards sawn therefrom is of no avail and, although the surface of

the board may appear clean, it will be found that the centre will be discoloured. Hardwood logs tend to split or surface check and the risk of borer attack is increased. In addition, the wood will be much harder to saw if partly dry and there will be a greater wastage due to splitting.

It is usually most profitable to saw the green log into boards of the final thickness required, allowing according to species to cover shrinkage.

If boards are cut into multiples of the thickness required with the intention of deepsawing after seasoning, not only will the time required for drying be increased in proportion to the thickness, but correct drying will be more difficult and seasoning defects will be increased. This may not hold when final thicknesses below $\frac{1}{2}''$ are required, as very thin boards may buckle in seasoning and increase handling charges.

It has been found good practice to dry boards in the widest widths available and subsequently to flat cut as required. This obviates a considerable amount of the casting and distortion which occurs in seasoning small sizes. The smaller pieces when cut dry will, moreover, retain their exact widths, a great help in floor joints, for example. In addition, the allowance for shrinkage will be decreased. Large widths do not take an appreciably longer time to dry than narrow ones.

As timber dries out much quicker from the ends than from the sides or faces, it may be an advantage to cut short lengths of boards if the wood is tolerant, but when, as in many hardwoods, bad end-splitting is characteristic, it would be preferable to dry in long lengths which saves handling and facilitates stacking. To minimise waste from end-splitting and save timber the rough log should always be sawn to the longest convenient length.

Climatic Conditions.

Air seasoning has often been called natural seasoning, which gives the impression that it is a much less severe type of drying than kiln drying. This is only partly true since conditions within a kiln are under complete control and can be altered to suit the class of timber being handled, whereas in air drying timber may be exposed to conditions of humidity which may easily cause severe degrade.

Conditions in South Africa vary considerably from one extreme to the other. The early summer on the High Veld with hot dry winds offers the worst conditions for drying heavy hardwood timber, the very rapid drying resulting in bad surface checking; while in certain areas near the forests in the northern and eastern Transvaal it is almost impossible to get any drying at all in the rainy season and kiln seasoning has to be resorted to.

Stacking.

Old as this method of seasoning is, it was not realised until recent years that certain attendant conditions could be controlled so as to secure optimum results and obviate wastage.

The method of stacking and the type of stack used has a considerable effect on the condition and drying rate of the timber and to obtain the best results it is important that certain simple rules should be observed.

The stack should be built on firm and level foundations which will allow of at least a foot clearance between the ground and the bottom layer of the pile, and the bases should be arranged in such a way that

they offer the least obstruction to the free passage of air beneath the stack. If possible slightly sloping ground to ensure good drainage should be made use of as a stacking area and this should be kept clear of weeds and rubbish which might interfere with the proper circulation of the air.

The foundation may be built of brick, concrete, or wood, or a combination of the materials. A very satisfactory form of foundation can be made with creosoted wooden poles about 2′ 6″ long and 4″ in diameter placed 18″ in the ground at two to three feet centres depending on the load to be carried and the type of timber to be handled. Over these are placed, horizontally round poles 4-5″ diameter slabbed on two parallel sides to 2½″ or 3″ thickness and kept in place with hoop iron (see Plate V). Foundations of this kind allow the maximum circulation beneath the stack, where the cold moisture-laden air always tends to accumulate and thus promotes even drying.

It is always desirable to season timber, particularly hardwoods, under cover. If, however, this is not possible, stacks may be partially protected from the sun and rain by means of portable roofing made up in the form of weather boards or slabs or other low grade timbers, which are placed on top of the stacks and moved about as required. The roofing should project well over the sides and ends of the stack and may be secured by wire tied to projecting stickers in the stack. Stacks may also be sloped sideways against the direction of the prevailing rain to assist run-off and facilitate roofing. This can be done by sloping the foundations as shown in Plate V.

Parallel Stacking.

The boards to be seasoned can rest directly on the horizontal supports, and the length of the pile will normally be that of the length of the boards. The width of the piles, except where square piling which is referred to later is resorted to, should be between 6 and 8 feet. Wider piles than this result in uneven drying unless chimneys are used.

There are various ways of stacking piles with uneven lengthed timber, but as far as possible boards of one length should be stacked together, and on no account should boards be allowed to overhang from the end of the stack as this will certainly result in warping and surface checking.

In building stacks of uneven lengths of boards it should be arranged for the gaps between the shorter boards to occur within the centre of the stack. Small sections of wood of the same thickness as the boards, placed between the stickers where these gaps occur, give the necessary support to the rest of the layers. Stacks of this sort will then normally be approximately twice or more times the length of the boards contained in them. Each layer in the stacks will be separated by means of stickers or cross pieces to allow the air to pass through the load. Throughout individual layers stickers must be of one thickness and are best cut to a thickness of 1″, a width of 1½″ and to the width of the pile in length and it is absolutely essential that they be placed in vertical alignment and immediately over the foundation support. If thicker stickers are to be used in the lower portion of a stack to increase the drying rate in that part they should be well differentiated in dimension from the remainder, or trouble may be caused by mixing them in a higher layer.

In many cases boards from the pile are used as stickers, but this is not good practice since they are usually too wide and may thus cause blueing and uneven drying at the point of contact of the surfaces.

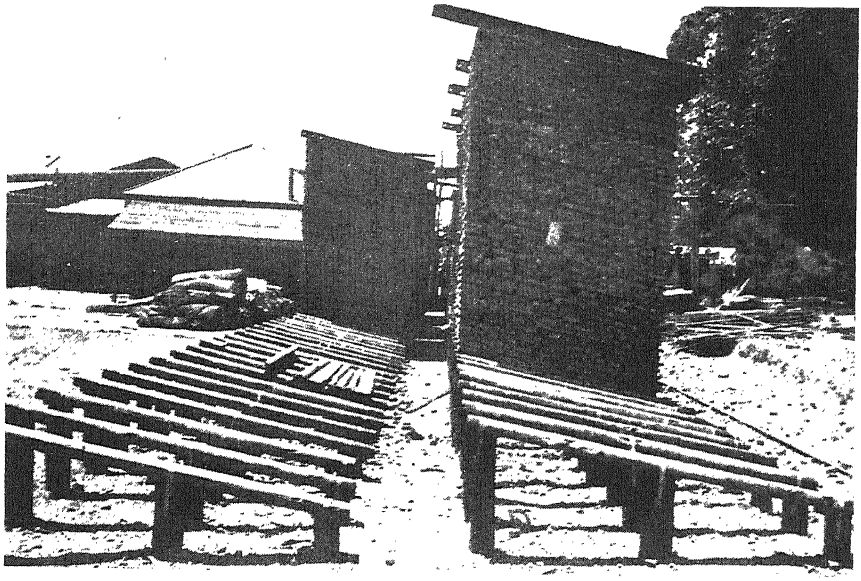


PLATE V.—Creosoted wooden stacking bases for air-seasoning, sloped to assist run-off of rain-water.

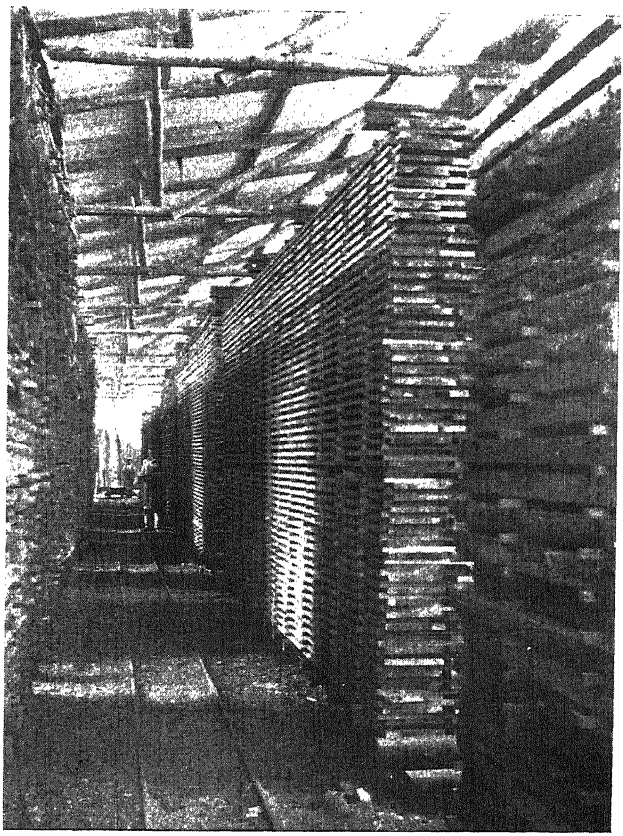


PLATE VI.—Timber stacked under cover for air-seasoning at Forest

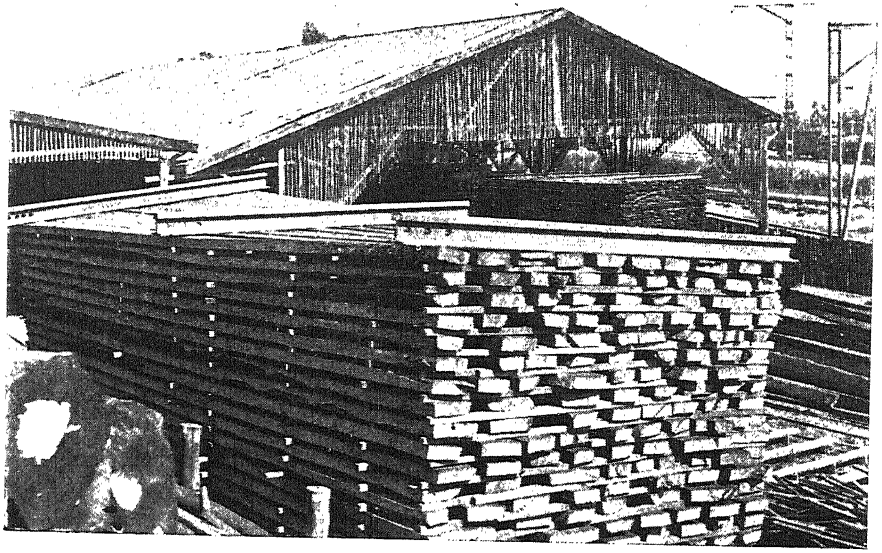


PLATE VII.—Stack of 2¼in. thick pine timber sawn from fast grown trees, shewing twist in individual boards and in the entire stack that is apt to occur when thicknesses exceed 1½in. Compare Plate VIII.

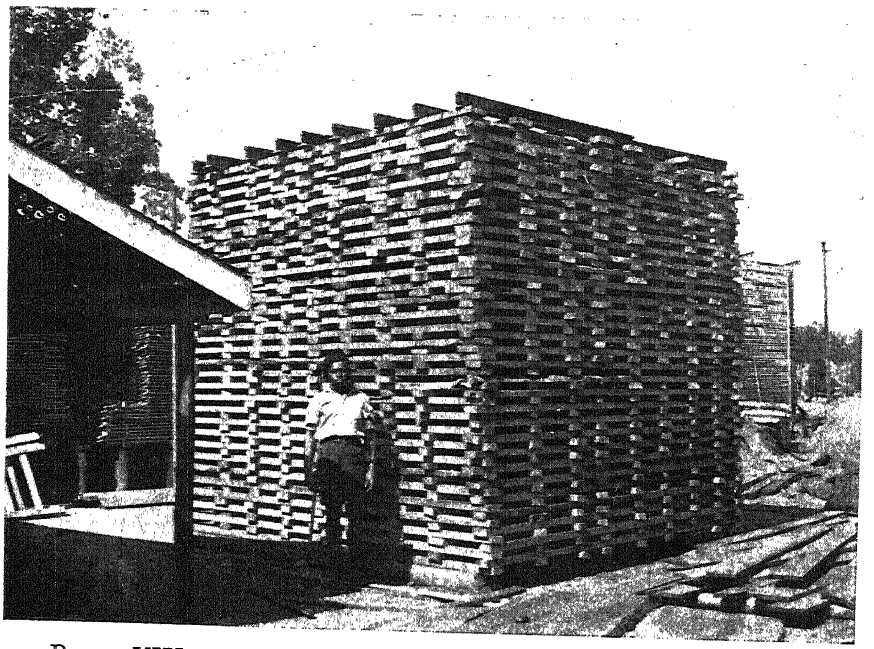


PLATE VIII.—Seasoned timber similar to that shewn in Plate VII. Note freedom from twist secured by square stacking.

For moderate rates of drying the boards in the individual layers may be placed edge to edge and for especially fast drying a space of from 1″ to 2″ may be left between edges. If the boards are of the same width this results in vertical chimneys in the pile, which still further increases the drying rate. Height of the piles is limited only by difficulties of stacking. They should be as high as possible consistent with stability.

The methods described above have been found to be entirely satisfactory for hardwoods and for the thinner dimensions of pine timber. (See Plate VI.)

Square Stacking.

In stacks composed of thin boards the weight of the wood itself is usually sufficient to prevent undue twisting of the boards, but with boards upward of 1½″ in thickness the whole stack may assume a warped condition in spite of considerable artificial restraint. (See Plate VII.) In this connection it is a curious fact that with the majority of the fast grown local pines and other softwood species dealt with, direction of the twist occurring during drying is invariably in one direction. It has been found that very open square stacking of the thicker material is of considerable help in avoiding this twist. Boards are stacked 12″ to 18″ apart in the layers and alternate layers are at right angles to each other. In this way the tendency to twist is neutralised to a large extent and rapid drying takes place owing to the wide spacing of the boards. The method is somewhat inconvenient, occupies a great deal more space than parallel stacking and may also result in a large degrade from splitting and possible blueing, but has much to commend it so far as twisting in concerned. (See Plate VIII.) With rather closer spacing of alternate layers, dimensions stock such as billets for handles may also be dried by this method.

Progress of Drying.

The times given in Table II are the average of a number of runs made under favourable conditions. The times for individual runs vary greatly as can be seen from the last column. The table should be used with discretion and only after due consideration has been given to the notes that follow. The only accurate method of determining the correct time in any particular case is by means of samples. It must be emphasised that these are the times after which under highveld drying conditions the wood will only have reached the degree of dryness shown and that it may not be, and usually is not, sufficiently seasoned for any but comparatively rough usage.

Wood dries rapidly from the surface, and as the surface moisture is evaporated the moisture from within tends to move out to take its place. Unless drying is abnormally slow, however, the moisture evaporates more quickly from the surface than it can be replaced. The result is that the outer layers tend to shrink over a wet interior and are forced either to develop small cracks or to dry in a stretched condition. When eventually the inner portion does dry the stresses are reversed and the tendency is for the outer layers to be compressed, with a tension set in the inner layers.

A two-inch thick board in this condition in being deep cut into two

TABLE II.

AIR DRYING PERIODS FOR VARIOUS SPECIES AND DIMENSIONS.

Name of Species.		Thickness. Inches.	Moisture content.		No. of days drying.	Minimum time recorded
Common.	Botanical.		Green.	Final		
Patula	*Pinus patula*	5/8	207	12	28	13
		1 1/16	180	13	50	36
		2 1/2	193	13	90	58
Insignis	*Pinus insignis*	1 1/16	65	13	32	25
		1 5/8	106	13	48	32
		2 1/2	80	14	60	45
		3 1/4	91	14	100	66
Yellowwood	*Podocarpus* spp	1 1/8	110	12	46	30
		1 5/8	124	14	70	50
Saligna	*Eucalyptus saligna*	1 1/8	120	12	100	60
		2 1/4	111	13	240	—
		3 1/4	93	15	400	—
Karri	*Eucalyptus diversicolor*	1 1/16	77	14	115	80
		2 1/2	80	14	270	—
Kiaat	*Pterocarpus angolensis*	1 1/16	67	12	90	50
		1 1/8	60	12	150	—
		2 1/4	68	13	200	—
		3 1/4	77	14	400	—
		5 5/8	92	14	600	—
Stinkwood	*Ocotea bullata*	1 1/8	83	12	90	50
		1 1/8	83	15	65	—
		2 1/4	85	12	250	—
			85	16	160	—
		3 1/4	84	12	400	—
			84	16	250	—
		4 1/4	72	16	400	—

one-inch boards will tend to grip the saw, and the thinner boards will tend to cup, i.e., the freshly-cut surfaces will become concave and the outer sides convex. The condition is known as casehardening and the stresses will often manifest themselves when the outer layer is planed off or their balance upset in any other way. Similar stresses are encountered in intermediate stages of drying when the distribution of the moisture is very uneven. Boards cut from wood in this condition also cup and warp as it assumes a condition of equilibrium. The stresses formed are more severe in some woods than in others, but, given time, they disappear in most wood.

From what has been said it can be appreciated that the stresses in timber may be severe at the end of the drying periods mentioned in the list above, and the need either for a longer period for air seasoning in order to give time for the dispersal of the stress, or for a short conditioning treatment in a seasoning kiln will be evident.

As a rough rule six months per inch thickness may be taken as a suitable time for softwoods and a year for hardwoods, but this will vary greatly according to the drying condition and the type of wood. After these periods with very few exceptions wood should be thoroughly seasoned.

It is, of course, not essential to season timber to this degree for such purposes as ordinary rough building construction, telephone poles, cross

arms, or even certain types of strip flooring, but for joinery, panelling and especially for wide surfaces in furniture-making the best seasoning possible is required.

It should also be noted that the rate at which green timber dries is very much greater in the initial stages than in the final stages. This is due largely to the preponderance of free water that is evaporated in the initial stages, and is a fact that may be made use of to increase limited kiln capacity by combining air and kiln seasoning. But more of this later. The difference in rate of drying at two periods taken from a few actual runs is shown in Table III. Since the runs were not made at the same time the rate of drying between species is not necessarily comparable.

TABLE III.

RATE OF AIR DRYING DURING PRELIMINARY AND FINAL PERIODS COMPARED.

Species.	Rate of drying per day.	
	Green to 20%	20% to 12%
Pinus patula	10·60	·50
Yellowwood	4·30	·45
Pinus insignis	4·30	·40
Saligna	1·20	·26
Kiaat	1·00	·20
Karri	0·99	·12

Although, as previously observed, one-inch thick stickers are generally most satisfactory for the drying of hardwoods, it is sometimes advantageous to use them as thin as half an inch. By this means a greater volume of timber may be stacked to the same height on any given area, which is of importance if shed space is limited. For 1″ sawn boards the use of ½″ instead of 1″ stickers will increase the volume of the stack by one-third. The effect on the drying rate for 1″ kiaat is shown in Figure 1. An increasing deviation occurs to begin with, but at the end of the run there is a very small difference in the final results. Thinner stickers can be recommended for drying hardwoods where boards are square-edged and especially in very hot dry weather, where damage might be done if the wood dries too fast.

The only sure way of determining how a stack of timber is drying is by means of samples. These samples are pieces of timber representative of the timber in the stack. They may be fitted loosely into the stack as it is built up so that they can be withdrawn at intervals and weighed. For convenience they can be cut quite short, two or three feet, and if properly end-coated should dry out at the same rate as much longer boards. By rebating the stickers above and below the sample, the latter can easily be placed in the centre or any other part of the load. In the experiments carried out at the Institute as many as ten sample pieces have been placed in single piles to determine the relative rates of drying in different parts of the stack. For ordinary purposes, however, two or three samples are as many as will be required. In the case of three being used one would be placed on each side and one in the centre of the stack.

The method of preparing samples is as follows. Having selected representative boards discard at least one foot from each end. Then immediately cut, say, a 30″ length from one or other of the freshly-sawn ends. From each end of the 30″ sample cut a full section about $\frac{3}{8}$″ or $\frac{1}{2}$″ thick, across the grain. Remove all splinters and weigh the

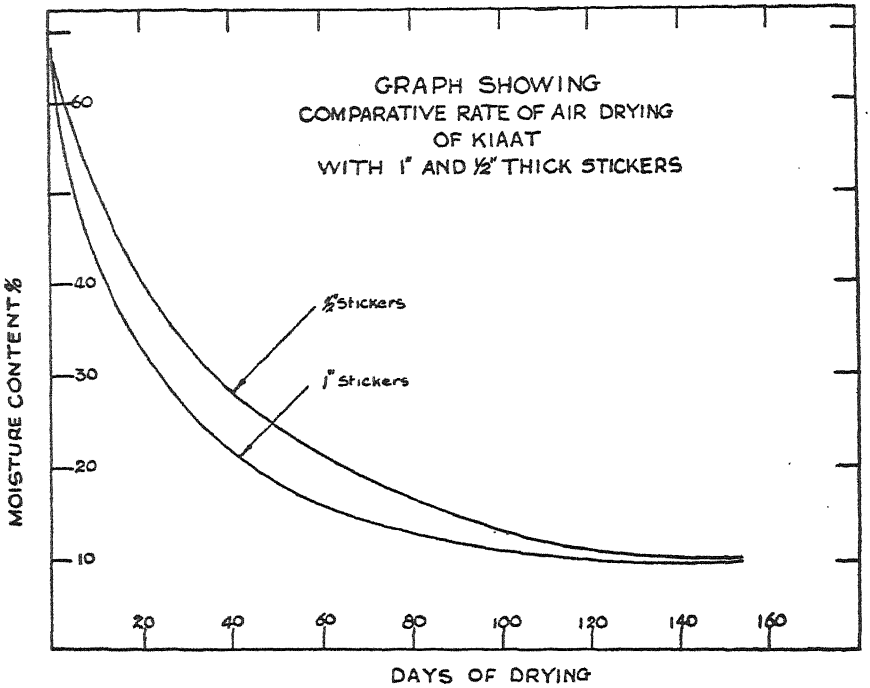


FIG. 1.—Influence of sticker height on rate of air-drying.

two pieces separately and proceed as described for determining moisture content. In the meantime weigh the remainder of the 30″ sample piece, end-coat both ends* and place in position in the load. The weight of the end-coating may be ignored. When the average moisture content of the two small sections cut from the sample is known (it is assumed that this is the mean moisture content of the sample) the dry weight of the sample itself can readily be calculated as follows:

$$\text{Dry weight} = \frac{100 \text{ Wet weight}}{\text{Moisture content} + 100}$$

The condition of the load as represented by the samples can therefore easily obtained at any time by simply weighing the samples and using the simple formula:

$$\text{Per cent. moisture content} = \frac{\text{Wet weight} \times 100}{\text{Dry weight}} - 100$$

By means of a slide rule this calculation can be made in a few seconds.

*A high melting point bitumen (70%) and cement (30%) melted in a pot and well mixed together has been found to be very effective for this purpose.

Kiln Seasoning

Kiln seasoning may be regarded from two points of view. The first and probably most common one is that of the sawmiller who wishes merely to prevent his product from blueing and to reduce its weight. This is the case with timber dried for box shooks or building timber. There is usually a considerable difference between the moisture content of the driest and wettest boards in the load and little if any attempt is made to relieve stresses which may have developed during the drying process. In these cases the rate of drying is usually of most importance as output is the chief consideration and more degrade from warping and surface checking is permissible than in the case below. Softwoods mainly are included in this case and the value of the product strictly limits the amount that can be spent on seasoning. Less skill is required in drying the wood under these conditions.

The second point of view is that of the sawmiller or manufacturer who wishes to produce a thoroughly seasoned product which, having been dried out to the optimum moisture content and free of all stresses, will remain true and free from shrinkage. Here time, though of importance, should be of secondary consideration, and as more expensive products in the form of hardwoods for furniture, joinery and panelling are concerned, considerably more can be profitably spent in obtaining the best seasoning possible. Certain softwoods for finished work may, of course, be included in this class, just as many uses may be found for hardwoods which do not necessitate seasoning to any high degree, e.g., telephone pole cross arms, heavy leg stock, etc. In this case careful control of drying conditions is essential and only a fully trained operator with long practical experience can obtain good results.

It should be emphasised here that even with a most up-to-date and efficient kiln, good results cannot be expected unless the operator is well acquainted with his work, while even with a comparatively inefficient kiln a good operator may be able to season timber satisfactorily.

Advantages of Kiln Seasoning.

The main advantage of kiln seasoning is that timber may be dried under the conditions which suit it best. Temperature and humidity being under control, defects can be reduced to a minimum. Very hot dry weather shortly after a stack of hardwood has been put out to air-dry may result in severe degrade that could be avoided in a kiln.

The time taken to kiln season is usually about one-tenth to one-quarter that required for air-drying. This results in numerous savings, particularly in capital tied up in large stocks in air seasoning yards and in fire insurance.

Kiln seasoning allows of drying the timber to any desired moisture content and drying it comparatively free of stresses. It also sterilises the wood—destroying adults, larvæ, or eggs of borers which may have been present in the wood, and creates conditions unfavourable for the development of blueing.

The owner of a kiln is independent of weather conditions and is able to supply customers' orders in a more efficient manner.

Types of Kilns.

There are a very great many different types of kiln, but they can be sorted out into two main divisions.

Natural Draught Kilns.

In the first group are those kilns in which the air movement is dependent on differences in temperature within the kiln. There are no fans to force the air through the piles. Hot pipes or flues below the timber cause the air to rise and enter the load. As the air ascends it passes over the boards evaporating a certain amount of moisture from them, itself being cooled in the process. As it cools it tends to fall and spaces are so arranged within the kiln that the cooled air descends again to the space below the heating pipes. A certain amount of the moist air escapes through vents to the outside and is replaced by fresh air just before it reaches the pipes to be recirculated. In the simplest types most of the air is drawn out by chimneys immediately it has passed through the load. This, of course, results in a considerable loss of heat.

Drying in natural draught kilns is slow, i.e., when circulation is dependent on difference in temperature of the air, and difficult to control accurately. They are not recommended for softwoods or other woods with high moisture contents, although in expert hands moderately good results can be obtained.

On account of the greater spaces which are usually left between the boards to encourage proper circulation the capacity of this type of kiln is often less than the forced draught type.

Forced Draught Kilns.

Nearly all the more modern types of kilns are worked on the forced draught principle, and air is forced from one side of the load to the other by means of fans which may be placed within or without the kiln chamber itself.

In the latest types fans are arranged at intervals along the length of the kiln on a false ceiling, or to one side of, or below, the load. As the air leaves the fans it passes over steam pipes to become heated up before entering the load. Passing through the load it dries the timber and is cooled in the process. It is then drawn towards the fan again and recirculated. Vents behind the fan can be used to let in fresh air, while if the air is too moist other vents just in front of the fan may be adjusted to allow the right amount of moisture-laden air to be expelled, as shewn in Figure 2.

The internal fan kiln has some advantages, the main one of which is the uniform delivery of air at several points along the kiln chamber, with fewer baffles than is usually necessary in the external fan types. In the latter type, which have given excellent service for many years at the Forest Products Institute, the air is driven into the kiln along a duct running the length of the kiln by means of a single fan placed outside the kiln chamber itself. The air then circulates through the load and is drawn out on the opposite side by means of another duct by which it returns to the fan. Steam sprays and fresh air vents adjacent to the fan may be regulated to give the required humidity. Heating may be accomplished by drawing the air through a nest of steam pipes behind the fan or over pipes arranged along the length of the kiln within the entering air duct.

The natural draught as well as the forced draught method of providing circulation may be applied to comparatively small single chambers known as compartment kilns or to much larger chambers which are usually 90' or

more in length and are known as progressive kilns.

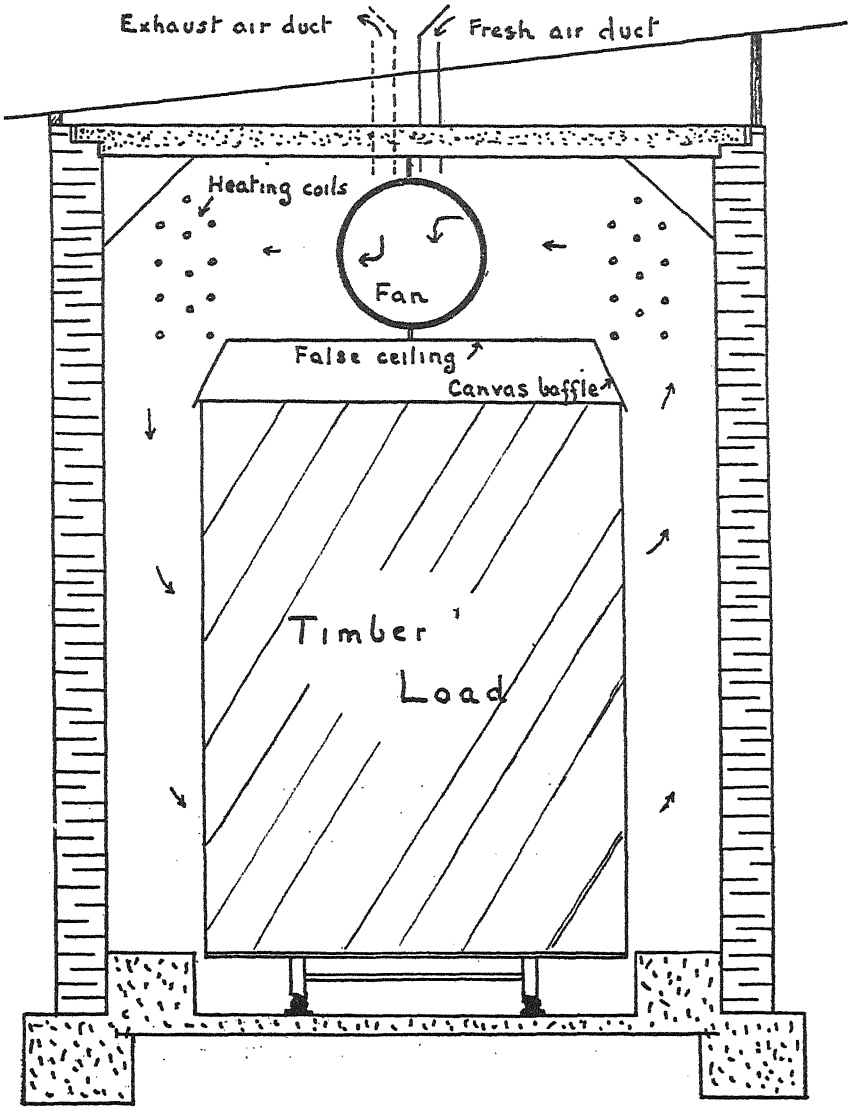


FIG. 2.—Cross-section of single load overhead internal fan kiln.

Progressive Kilns.

In these the conditions of temperature and humidity at the two ends vary, and the four or more loads which the kiln contains are periodically moved and in turn pass from the " green " end to the dry end of the kiln as fresh loads are fed in and the dried loads extracted, as shewn in Figure 3.

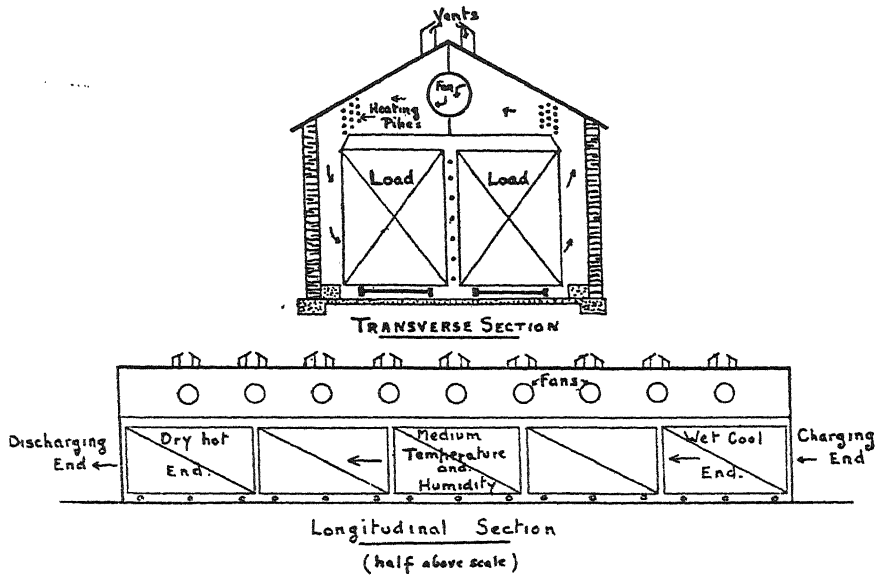


FIG. 3.—Progressive kiln.

The disadvantage of progressive kilns is that they must be completely filled to function properly and they are therefore suitable only when very large volumes of the same kind and thickness of timber are to be dried. They are essentially for use with easily dried softwoods, as no steaming or high humidity treatments can be carried out to relieve stresses to suit individual loads. Owing to difference in original moisture content, density, etc., timber emerges with a larger range in moisture content within the load than in compartment kilns.

Two such kilns are in constant use by the Department of Forestry and two others are in course of erection, and the results obtained are entirely satisfactory for the purpose in view, i.e., the drying of conifers, mostly *P. patula* for agricultural and commercial boxes, as well as a smaller amount of building material. The output from a kiln of this kind may be up to 30,000 c. ft. per month and the cost of operation is lower than for compartment kilns.

Compartment Kilns.

Compartment kilns, on the other hand, are particularly useful when various kinds and thicknesses of timbers have to be dried. They can be built of a size to suit any need and additional chambers can readily be added if desired. Closer control is possible so far as the condition of the timber is concerned.

The conditions in any part of the kiln at one time are the same, and are changed to suit the particular load being dried. Compartment kilns are most suitable therefore when valuable hardwoods are to be dried and degrade reduced to a minimum. A skilled operator is required to run a battery of compartment kilns, but one man can manage a large number of kilns and it is usual if only one or two kilns are erected for him to have charge of other work as well.

Construction of Kilns.

Kilns may be constructed of various material, such as wood, concrete, hollow tiles, brick or even canvas, but for permanent work brick walls with reinforced concrete roof and concrete floor are recommended.

Cavity walls are preferred to solid walls as they offer better insulation. The floor should be slightly sloped towards the door to allow of drainage. Precautions should be taken in the concrete work to allow for expansion occurring on the kiln being heated to high temperature. Creosote treated wood or black iron may be used for baffles and copper nails or screws are well worth the extra cost involved in using them.

The inside of the kiln should be well painted with a good grade of bituminous paint.

Doors are important items and may be made of treated wood and asbestos sheets, or with steel framing insulated with wood on both sides. Some sort of insulation is essential to avoid loss of heat. Various types of kiln door fittings are on the market and perhaps the most convenient kind are those which are hung on hooks from an overhead attachment and held close to the framework by means of a number of clamps. To open them they are lifted off the supporting attachment by a special device and moved to one side or the other along an overhead rail.

Small double inspection windows at the side or end of the kiln are strongly recommended. These can be used for checking temperatures and humidities.

It is infinitely easier and much more efficient to load the kilns by means of trucks outside the kiln and run them on rails than to load timber directly into the kiln. Rails should therefore be laid in the floor and levels adjusted to suit the yard levels outside.

Sawdust should be used on top of the concrete roof for purpose of insulation and a light roof is required above this to protect it from rain. It may be noted that galvanised iron if used inside the kiln rapidly deteriorates.

Auxiliary Equipment.

Proper seasoning cannot be carried out by guesswork and the following items of equipment are essential to satisfactory results:

An electric or steam heated oven in which moisture discs can be dried out, and which can be kept at a constant temperature a few degrees above the boiling point of water. Home-made ovens can with a little experiment be made surprisingly accurate in this respect.

A small saw on which the moisture discs and the casehardening and moisture distribution tests can be cut.

A triple beam or other type of balance with a capacity of about 100 grammes, weighing accurately to ·02 grammes, and a larger balance with a capacity up to about 15 lbs.

A slide rule will be found to be of great assistance in calculating rapidly the moisture contents and other figures.

At least two *Hygrometers,* which in their simplest form consist of two thermometers mounted side by side, one of which is a wet bulb, should be available for each kiln chamber. Charts from which to determine the relative humidity are usually supplied with the hygrometers. Recording hygrometers make a continuous record on a chart of both

wet and dry bulb readings and are installed in most large plants but are not essential.

Suitable *trucks* for loading the timber outside the kiln with at least one spare one, and a *traverser* where several kilns are operated, complete the incidental equipment.

Control.

Some of the main types of kilns have been very briefly described, but the number of different kilns is very great and it may be difficult to decide on the best type for the purpose in view. It will be helpful therefore to bear in mind the fundamental requirements of a good kiln, which are an ample and uniform circulation of air, a sufficient supply of heat which can easily be controlled, and quick and easy means of supplying the required amount of humidity to the heated air. Each of these three requirements and methods of stacking and operation are discussed in this section, and a number of schedules appropriate to the seasoning of the species enumerated in the notes at the end of the paper, appended.

Circulation.

In all modern kilns the air which is used to dry the timber is to a large extent recirculated over and over again, a small additional amount of fresh or comparatively dry air being added as required. It is essential that the circulation be uniform to all parts of the load. This is a very important point since uneven circulation means uneven heating as well as differences in humidity within the kiln, which will result in patchy drying, one of the most irritating faults in kiln seasoning.

Stacking in the kiln truck is carried out in the same way as for normal air seasoning. If the direction of the draught is horizontal, which is usually the case, it is highly important to see that the edges of the layers on the entering air side are in perfect vertical alignment and for this purpose stacking forms may be used. These are simple arrangements which straddle the truck and present a vertical plane against which the edges of the boards may be aligned. Boards in the layers are placed closely together edge to edge.

Where the circulation in the kiln is in a vertical direction spaces of two inches or more are left between the edges of the boards in the layers and it is of no importance to have the outer edges of the layers in alignment. In this case it may be necessary to stack the truck so that a vertical chimney, the length of the load and a foot or so wide, is left in the centre of the load to induce the hot air from the pipes to rise. The chimney rises to within a foot of the top of the load where it is closed by the top four layers which are stacked without spaces between the boards.

For timbers with high moisture contents such as *Pinus patula,* which is easily dried, a much higher rate of circulation through the load is required than with hardwoods such as Karri. For air dry timber of thick dimensions much slower circulation may be used than for green timber or thin dimensions. It is generally accepted that for normal purposes a rate of approximately 1½ feet per second through the load is ample, although this may in certain cases, as indicated above, be increased to as much as 6 feet per second. It should be noted that it is

the relative humidity of the air which should decide the drying rate of the timber and not the rate of circulation, which should always be ample.

When there is insufficient circulation or with loads of very high moisture content, there will be an appreciable lag between the rate of drying on the entering and the leaving air side of the load. Reversible circulation has been introduced in many types of kilns to overcome this lag, and at the same time to enable wider loads than usual to be used. The volume of air required to be circulated should be calculated in each case but, bearing in mind what has been said above for a kiln 24′ × 10′ × 8′, the figure would be between 8,000 and 10,000 c. ft. per minute, and the fan capacity probably double these figures.

The complete air circulating unit then consists of one or more fans to deliver the volume of air required, ducts and baffles to distribute this air evenly to the whole load, and return it to the fan, vents for fresh and damp air, and the necessary motive power for the fans: in the case above from 3 to 5 h.p., depending on the type of fan.

Care should be taken to see that the best use is made of the air available; in other words, to see that there is no short circuiting of the air round the ends or below and above the pile. Canvas baffles and boards suitably placed will guard against this.

Uneven circulation and therefore uneven drying may be caused by overcharging the kiln. There should be ample space at the sides of the load for the air to circulate; 15″ to 18″ is a minimum space between the walls and the load, and about 9″ should be left between the ceiling and the top of the load. This space may be used for placing weights to counteract a tendency to warp in the upper layers. It is also very important that the edges of the various layers in the stack should be in vertical alignment. Boards projecting at the side may seriously interfere with the current of air entering several adjacent spaces.

Heat.

The universal practice is to use steam pipes for heating purposes. Patented pipes with fins of various kinds are on the market for increasing the efficiency of the ordinary steam piping and these are very effective in reducing the length of piping and the number of joints required. They are, however, somewhat expensive.

High steam pressures are not required; 50 lbs. is normally sufficient. With ordinary 1″ steam piping a very rough approximation of the number of lengths required can be obtained by dividing the area in square feet of the transverse section of the kiln by three or four, depending on whether high or low temperatures are to be used. The total length will naturally be the resultant figure multiplied by the effective length of the kiln.

Requisite steam consumption will naturally vary very much with the type of wood dealt with, the type of kiln, and many other factors, and only an approximation can be made even when this is known. A compartment kiln 24′ × 8′ × 10′ may be expected to use something like 150 lbs. of steam per hour. Actual figures of condensation indicate that from 1·4 to 1·9 lbs. of steam are required for each pound of water evaporated from the wood within the kiln. These figures apply to easily dried dimensions and not to thick sizes or to difficult hardwoods.

Temperature control is best accomplished by means of a thermostat

attached to the main steam supply to the individual kiln. These instruments are not expensive and are a great saving of time and anxiety to the operator as well as a safeguard against damage to the timber. The bulb of the instrument is fixed close to the hygrometer bulbs which record the wet and dry bulb temperatures of the entering air. Hand control of temperature though possible is difficult and generally unsatisfactory.

The complete heating unit consists of the main steam supply pipe, the nest of steam pipes within the kiln, with correct slope to the steam trap outside the kiln. From the latter the condensation is usually returned to the boiler.

Humidity.

Control of the humidity is exercised by vents and by means of injecting live steam through a pipe perforated along its length with small holes of about $\frac{5}{16}$" diameter. When fresh air is admitted through the vents it tends to reduce the humidity, since on heating it becomes very dry. Air which has become excessively humid is expelled through other vents.

Humidity can be controlled more easily by hand than can the temperature and for compartment kilns manual control is usual.

There are, however, instruments which automatically control humidity as well as temperature and at the same time make a continuous record of both wet and dry bulb readings. These instruments are used in conjunction with a compressed air outfit and therefore, except where there is a very large output, are not usually installed.

Stacking.

For the circulation, heat and humidity to be evenly distributed within a compartment kiln it is necessary to limit the size of the chamber. Thirty feet is probably the maximum length that it is convenient to work with, though 20′ to 24′ is perhaps more usual. The width of a single stack in the chamber should not be more than 6′ if lag between drying on entering and leaving sides is to be avoided and the height of the load should not exceed eight feet. With progressive kilns, however, the dimensions indicated above are greatly exceeded. The importance of correct stacking on the kiln trucks has already been dealt with under the heading circulation.

Kiln Operation.

There is a general feeling among many timber merchants, millers and others that a modern seasoning kiln is the solution to all their seasoning problems, and that it is only a matter of so many days in the kiln and the timber will be perfectly seasoned. The problem is, however, not quite so easily dealt with for two main reasons. First, timber varies considerably in its properties, and no two loads need necessarily receive exactly the same treatment, nor are the conditions in any two kilns exactly the same. Secondly, although the operator may know what is required in any particular instance he must also be in a position to see that the requirements are met. In other words, he must have a thorough knowledge of the part that shrinkage plays

in drying, must keep the pulse of the timber, as it were, and have sufficient practical experience to deal with contingencies as they arise. It is true, of course, that once progressive kilns have been set very little attention is necessary, but this type of kiln is only suitable for dealing with easily dried timber where stresses or differences in moisture content between boards of from 5 to 7 per cent. are of no great importance.

Before actually loading the kilns the operator will check over his instruments to see that they are working correctly.

When the kiln has been charged and the canvas or wooden baffles adjusted the doors will be closed, the fans started and the steam in the heating pipes turned on. Enough live steam will be admitted into the chamber to prevent damage to the timber, rather more than less than indicated on the schedule to be followed.

When the temperature has reached the desired figure the thermostat should be set and the humidity adjusted to the schedule which it has been decided to follow.

Once drying has started subsequent changes in temperature or humidity will be governed by the condition of the sample boards of which there should be at least two and preferably more, prepared as previously described under progress of drying.

Operators are naturally reluctant to go into the kiln more than absolutely necessary, but the periodic weighing at least every other day of the sample boards is essential as changes in treatment are made according to the rate of drying and the moisture content indicated.

For all accurate work where it is essential not only to have dry wood but wood free of all stress, control pieces may be used in kiln seasoning in addition to the samples. These pieces are prepared in the same way as samples and are cut from the same boards. The difference is that they are not weighed nor is their moisture content at the beginning of the run calculated. They are usually shorter than the samples and are used to determine the distribution of moisture in the wood and the stresses present while drying. They may be cut at any time during the run, but usually after the fibre saturation point has been reached.

As the wood dries the temperature is increased and the humidity decreased until the samples approach the final moisture content desired usually about 10 per cent. At this point, and at other points during the run, if signs of casehardening are present, it is advisable to use a high humidity treatment, i.e., increase the humidity to such a point that little if any drying will take place in the samples with the lowest moisture content while those which are of higher moisture content will continue to dry.

Steaming treatments in the kiln, i.e., allowing low pressure steam to escape into the kiln until the air is fully saturated at the temperature required have many beneficial results if properly applied. One of the most useful purposes achieved by them is the relief of stresses, particularly shortly after the commencement of a run, when an excessive moisture gradient exists, i.e., when the moisture content of the outer layers is very much lower than that of the inner portion. At this point the outer layers may be apt to rupture in their endeavour to shrink over a wet interior. The result of a steaming here softens up the comparatively hard outer layers and smooths out the moisture gradient preparing the way for further efficient drying. A steaming of this kind is usually carried out about 10 to 15° above the subsequent drying temperature.

In drying at low temperatures or when the kiln has been shut down with a wet load in it, heavy mould often occurs. This closes up the spaces between the boards so effectively that proper circulation is interferred with. A steaming treatment of short duration, a half hour or so, at 160° F. or more will clear all mould of this kind.

High humidity treatments are used with the same object as steaming treatments for the release of stress, but differ as a rule in that the air is not entirely saturated and may be circulating all the time. They achieve the same result but in a milder manner and are much more suitable for the relief of stress when the wood is below the fibre saturation point, i.e., when it is nearly dry.

A steaming treatment at this point may be dangerous as it expands rapidly the already compressed outside layers over a shrinking interior and may cause more damage than it was meant to prevent, by producing stresses in this outer layer which may finally result in surface checking when drying takes place again.

High humidity treatments may be used for a few hours or for two days or more, depending on the stress or the moisture gradient. Steaming treatments rarely last longer than three or four hours.

High humidity is used near the end of a run to prevent the samples which are already dry from drying further while any lagging samples may be given a chance to catch up with the others. In other words, high humidity assists in evening up not only the moisture gradient in any particular board but also the drying in different parts of a load.

Finally, when the test pieces cut from the controls or samples show no stress and an even distribution of moisture the kiln may be cooled and the load extracted. It is usual to cut tests from one or two boards in the load in addition to those cut from the sample to make doubly sure that the load is properly seasoned.

Operation of the kiln can be simplified by the use of Table IV, which

TABLE IV.

EQUILIBRIUM MOISTURE CONTENT FOR VARYING WET BULB DEPRESSION.

Depression of wet bulb. °F.	Equilibrium moisture content of wood. %	Depression of wet bulb. °F.	Equilibrium moisture content of wood. %	Depression of wet bulb. °F.	Equilibrium moisture content of wood. %
1·5	24	7	13	18	8
2	22	8	12·5	21	7
3	19	9	12	25	6
4	17	11	11	30	5
5	15	13	10	40	4
6	14	15	9	50	3

gives the equilibrium moisture content of wood for various degrees of depression of the wet bulb. The table can be used for all normal kiln temperatures.

The ordinary schedules used in kiln drying usually state the temperature and humidity to be used, but the intelligent operator is really much more concerned with the equilibrium moisture content at the stated figures than with the figures themselves, and therefore the relationship between

the depression of the wet bulb and the equilibrium moisture content of the wood if known are of greater value.

Schedules for Kiln Seasoning.

Although it is recommended that in the vast majority of cases, especially with hardwoods of heavy dimensions combined air and kiln seasoning should be practised, there are cases where kiln seasoning direct from the saw is desirable.

Numerous runs have been made at the Institute on the more common indigenous and exotic timbers and good results have been obtained with the same species with somewhat varying schedules. It has been found that there is an appreciable difference in the seasoning qualities, for instance, of *E. saligna* according to its weight.

It should also be borne in mind that a schedule for rapid drying of a species for one purpose cannot necessarily be applied for drying the same timber for another purpose. The degrade and final moisture content allowable vary according to the use to which the timber is to be put.

The schedules given in Table V cover the whole range of locally grown timbers so far dealt with at the Institute. The figures in brackets inserted after each of the notes on species in the concluding section indicates which of them should be applied to the kiln drying of 1 to 1½″ boards of the species concerned. They are for use in forced draught kilns with an average rate of circulation. The times required for thicker material are proportionately longer and milder schedules may be used. All readings are in respect of the entering air side of the kiln. It is not claimed that the schedules are perfect, but they are a good guide to satisfactory drying.

Some time after they had been prepared it was found that they compared very closely with the general schedules drawn up and published by the Forest Products Laboratory, Madieson, U.S.A. (10) and for the sake of uniformity some of the latter schedules slightly modified in form have been adopted.

TABLE V.

SEVEN STANDARD KILN DRYING SCHEDULES.

Schedule No.	Dry bulb temperature and depression adjustments for undermentioned moisture contents.									
	Green.		40%		30%		20%		15% to final.	
	Dry bulb.	Depression.	Dry bulb.	Depression.	Dry bulb.	Depression.	Dry bulb.	Depression.	Dry bulb.	Depression.
1	140	8	145	10	150	13	160	25	165	38
2	135	7	140	10	145	12	155	24	160	36
3	130	7	135	9	140	12	150	23	155	31
4	125	7	130	9	135	12	145	23	150	30
5	120	7	125	9	130	11	140	20	145	26
6	135	12	—	—	150	24	165	33	175	45
7	160	14	—	—	170	26	180	35	180	45

INTERMITTENT KILN DRYING

This form of kiln drying is not likely to be undertaken by any large timber concern but it is of interest to some of the smaller mills where

steam supply is perhaps limited to the working hours.

Although it may be thought that if steam is available only for, say, ten hours in the day drying times would be more than doubled, this is not necessarily the case.

When the supply of heat ceases these is, of course, a corresponding drop in the temperature in the kiln, but a certain amount of drying continues, the tendency being for the moisture to move out from the hot centre to the cooler surface. This in turn causes a decrease in the moisture gradient which is set up during the regular drying periods, and is generally beneficial.

Hardwoods respond well to this treatment, and although the drying time is naturally longer than under the normal course of kiln drying the method is entirely practical.

In drying softwoods in this manner care must be exercised to avoid shutting down the kilns over long week-ends and holidays with wet boards inside, since mould and discolouration very easily set in and develop with amazing rapidity under these conditions. Mould can, of course, be dealt with by steaming but discolouration cannot be removed in this way.

Combined Air and Kiln Seasoning

Mention has been made in the earlier part of this paper of the advantage to be gained in combining air and kiln seasoning methods and Table III indicates the very rapid rate of air drying in the initial stages of a normal air seasoning run compared with that in the later stages.

This latter point is further and more clearly illustrated in the graph in Figure 4, from which it will be seen that the rate of drying falls off very appreciably round about the time that the timber contains an average moisture content of 20 per cent., i.e., after about 45 days. To continue

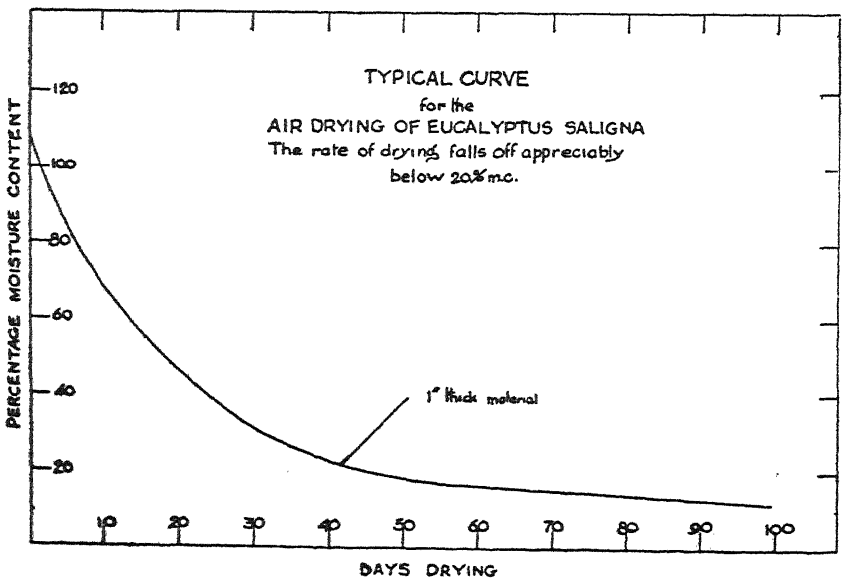


Fig. 4.—Air-drying progress.

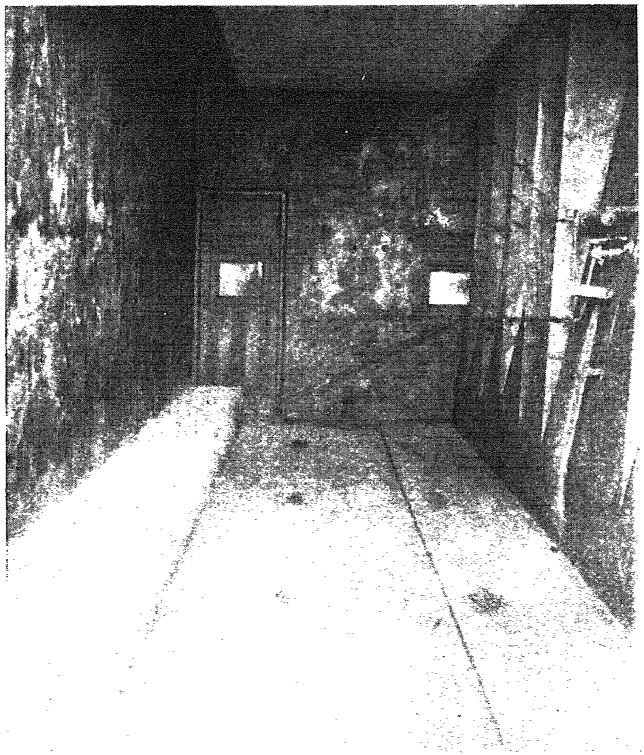


PLATE IX.—Interior of external fan kiln. Note sloping wall and baffles on right to regulate entering air-supply. Bulbs of control and recording instruments also on right. Inspection windows and door at far end, and walkway on left. Used air is drawn out along top left of chamber.

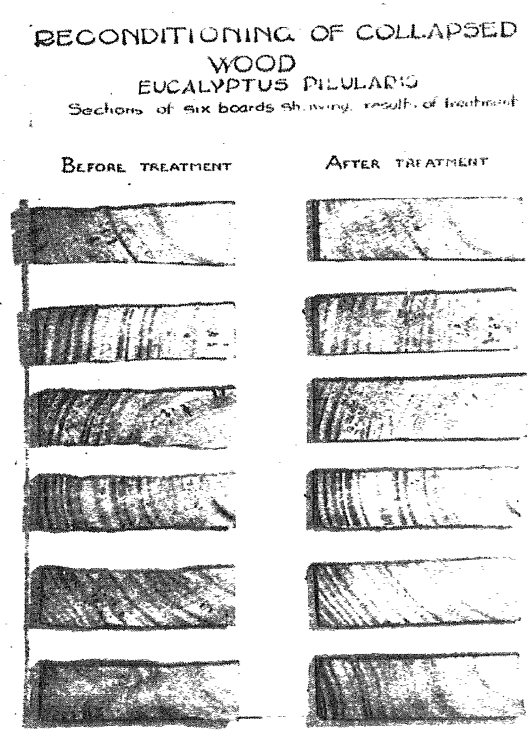


PLATE X.—Reconditioning of collapsed timber. Sections of *Eucalyptus pilularis* before and after treatment in kiln. Note general restoration of shape and closing of ruptured tissue, particularly in top and third section down.

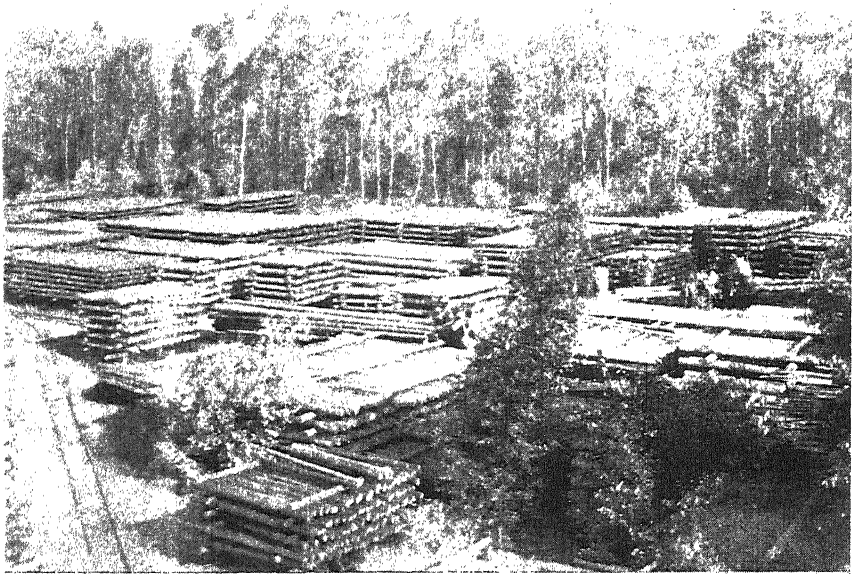


PLATE XI.—Poles drying out at Forest Products Institute preparatory to preservative treatment.



PLATE XII.—Close-up of an individual stack in yard illustrated in Plate XI. Note method of stacking, well off ground.

the seasoning of this in the air to an average moisture content of 11 per cent. would require approximately a further 60 days, and even after this time the wood would be somewhat stressed and would contain an uneven distribution of moisture, which might cause movement after machining. Karri in $1\frac{1}{8}$" boards air-seasoned for as long as a year under cover when run into parquet blocks showed sufficient shrinkage from stress to cause the blocks to be difficult to lay accurately. It is now the practice for all Karri for this purpose to receive final treatment in the kiln, after two to three months air drying.

In order to eliminate as far as possible any further movement in the wood an additional three or four months air seasoning would be recommended, and in some species such as Stinkwood it is possible that the stresses formed in air drying would persist for much longer periods. The total period for seasoning would therefore be about 170 days.

If the timber were to be kiln seasoned green from the saw the kiln would be occupied for a period of from 18 to 21 days. If, however, after a preliminary air drying of, say, 50 days, the loads were transferred to the kilns, seasoning could be completed in five to six days and the timber turned out in a total time of 56 days with an even moisture content and free of stress in the process. This would mean that the output of kiln seasoned timber could be more than trebled and the maximum advantage taken of both methods. The only disadvantage would be double handling of the load which would not, however, be a very serious consideration where hardwoods are concerned.

The case of *E. saligna,* an easily dried hardwood, has been cited above, but when timbers such as Stinkwood which have to be dried in the kiln at low temperatures and therefore occupy the kiln for a much longer time, have to be dealt with, the advantages of the combined method are still further apparent.

It might well be asked whether the preliminary air drying might not be a cause of greater degrade than would be the case if the wood were kiln dried directly from the saw. If, however, refractory timbers are piled for the air seasoning period as previously described for slow drying, there should be very little chance of this happening.

It is often necessary to treat the sapwood of such species as Kiaat in a preservative solution of Zinc Chloride or Zinc Sulphate to prevent subsequent attack by wood boring insects. This treatment is not effective if carried out on the timber directly after sawing from the log as the moisture in the wood prevents the absorption of a sufficient amount of preservative solution. It is most effective when the sapwood is dry and this is usually the case when the average moisture content of the boards has reached about 20 per cent. After treatment it is, of course, necessary to redry the timber to an appropriate moisture content. When the combined method of air and kiln drying is practised the preservative treatment may be used to fit in conveniently between the time the air seasoned stacks are taken down for reloading into the kiln. It should be mentioned that the redrying takes only a fraction of the time of the original drying since only the sapwood is included.

Woods which are particularly susceptible to attack are Rooi Essenhout *(Trichelia emetica),* Essenhout *(Ekebergia capensis),* Kaffir boom *(Erythrina caffra),* Maroela *(Sclerocarya caffra)* and Maculata *(Eucalyptus maculata).* But the sapwood of most hardwoods, especially the gums, are also liable to attack if not treated.

Reconditioning by Steam

Many of the lesser-known eucalypts and certain other woods such as Maroela often show signs of collapse during drying, which are manifested on the surface of the boards as numerous corrugations or uneven shrinkage. By means of a steaming or, to be more correct, a very high humidity treatment in the kiln this uneven shrinkage can be overcome and the boards restored to their normal size and shape with even less than the usual amount of shrinkage. Although honeycombing which may have accomapnied the collapsed condition cannot, of course, be cured, the cavities caused disappear as the wood expands and are difficult to trace by eye.

Plate X shows sections cut from boards of *E. pilularis* before and after reconditioning treatments.

The time required for reconditioning different timbers varies, but for 1" thick boards of *E. pilularis* it has been found that an 8 hour treatment at temperatures between 196° and 205° F. with humidities of near 96 per cent. achieves the desired results without difficulty. Gradual cooling of the load after such severe condition of temperature is essential. Boards undergoing this treatment are stacked in the ordinary way for kiln seasoning but it is advisable to have a special chamber where the reconditioning is carried out. Although it can be quite well done in any kiln, the effect on the building, pipes, etc., of such high temperatures and humidities is not good.

The reconditioned wood being larger in section is easier to work, finishes to a better size and has a better appearance.

For the treatment to be effective the wood must be dried to about 10 or 12 per cent. moisture content. It is quite normal practice to sort out boards which have collapsed in air seasoning when they are being fed to a moulding or other machine and have these " blown up" so that they will stand up to the full finished size of the remainder of the consignment.

Drying of Round Timber

Timber dries out exceptionally slowly in the log and in most cases the sapwood rots before the heartwood is even half dry. Kiaat logs 14" to 18" in diameter, for instance, which had been felled and stacked in a loose pile for 8 years showed a moisture content of 70 to 80 per cent. within a few inches from the surface, while a 15" log of *Eucalyptus rostrata,* felled 11 years before the moisture tests were made, also contained very nearly its original moisture content in the centre of the log. In both cases the sapwood had rotted away to a greater or less extent.

Pine and other softwoods, of course, dry very much quicker than this owing largely to the greater percentage of sapwood which they contain. Nine inch diameter *Pinus patula* logs stacked off the ground and exposed to the sun after barking were dried to 20 per cent. moisture content in 7 months.

Small sized gum logs or poles for preservative treatment may be stacked as indicated in the photograph of portion of the preservative yard at the Forest Products Institute (Plate XI) and will usually be sufficiently dry for treatment, i.e., below 20 per cent. moisture content in the times indicated in Table VI.

For railage and other purposes it is often necessary to know the

percentage loss of weight which is likely to occur after varying periods of drying and, although comparatively little work has been done on this, the graph in Figure 5 indicates the results on tests carried out in Pretoria on three heavy eucalypt species.

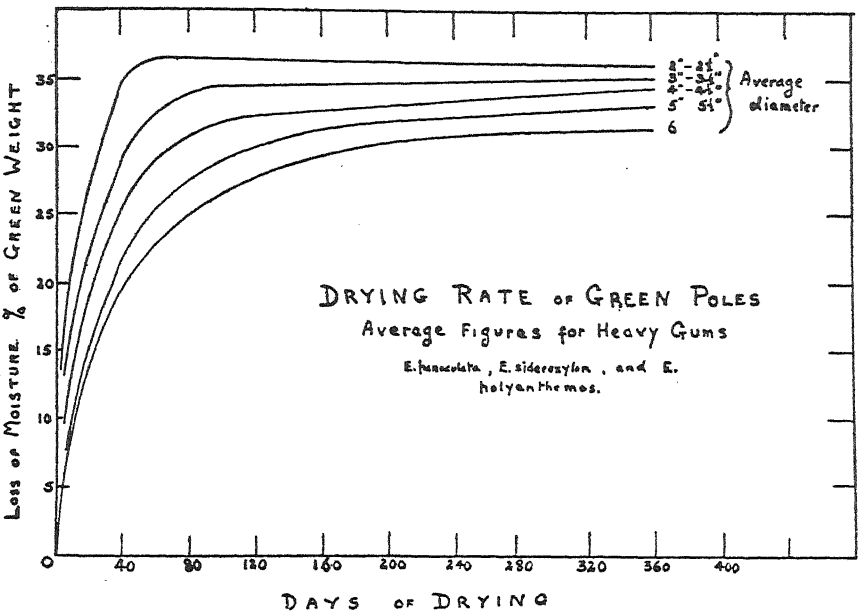


FIG. 5.—Drying trend of poles under Pretoria conditions.

TABLE VI.

AIR-DRYING TIMES FOR ROUND TIMBER.

Mean Diameter.	Months of Drying.	
	Gum.	Pine.
8″	9—12	5—6
6″	6— 8	3—4
4″	4— 5	2—2½
3″	2— 3	1—1½

The times indicated in Table VI and in Figure 3 are all for barked poles dried out under favourable conditions. Poles should not be dried with their bark on.

DEFECTS IN SEASONING

Splitting.

The most common defect met with in seasoning timber is probably end splitting. In some cases, such as with eucalypts, the splitting at the ends of the logs and subsequently in the sawn boards is not due to drying stresses but to forces inherent in the living tree which are largely released when the log is sawn into boards. These

stresses appear to be present in a great many species besides the eucalypts but are undoubtedly most severe in the latter. For such splitting little can be done because the most severe damage takes place in the log or while the boards are being sawn, and has actually nothing to do with drying. The occurrence of end splitting during drying is due to the fact that wood dries out more rapidly from the end grain than from the faces or edges, and in addition the ends are the most exposed surfaces. It follows that the end tends to become narrower than the remaining portion of the plank so that one or more splits may therefore occur. The obvious remedy is to protect the ends as far as possible from the sun or wind. This may be accomplished in very valuable woods by means of an end-coating (which, however, is usually too expensive for ordinary timber), by placing stickers as near the end of the boards as possible (wider stickers than usual are an advantage in this case and can be made to overlap the ends) or by covering the end of the pile with canvas or waste wood. The use of "S" irons or metal and wooden strapping is of doubtful value in preventing splitting and may actually increase the tendency to split. Used on boards which have already split badly they are of use in preventing the splits from gaping.

In kiln seasoning end splitting may result from excessive circulation round the end of the pile and too low humidities. Plain sawn boards are more liable to split in this way than radially sawn ones.

Warping.

In the utilisation of young fast-grown pines much trouble is experienced by warping. This is due to the variation in shrinkage in tangential, radial and longitudinal directions which has been referred to before, and is particularly severe in knotty wood since in the vicinity of knots the grain is usually badly distorted. Warping may take a number of different forms. The most common is perhaps the twisted or spiral inclination. Cupping, as illustrated n Plate XII, is common in boards sawn from the outer portion of the logs especially if the logs are of small size and there may be all kinds of combinations of these shapes.

Warping is accentuated when compression wood is present. This wood is usually of a darker appearance than the normal wood, rather like the summer wood portion of the annual ring but more irregular in occurrence and has the property of abnormally large longitudinal shrinkage. Boards sawn from logs containing this type of wood bow badly in their length and often spring out when stacked on the edge of a stack, such is the force exerted.

Apart from the correct stacking methods mentioned previously, warping may be reduced by drying out boards in as wide widths as possible before finishing to smaller sizes. Slow drying at low temperature usually also reduces the amount of warping as the outward flow of moisture is then less interrupted.

Surface Checking.

Surface checking (see Plate XII) is a common defect due to uneven and too rapid drying hence shrinkage of the surface in relation to a wet interior is induced. Hardwoods are particularly prone to this defect since they have less " give " in them than softwoods and the stresses formed rupture the outer tissues.

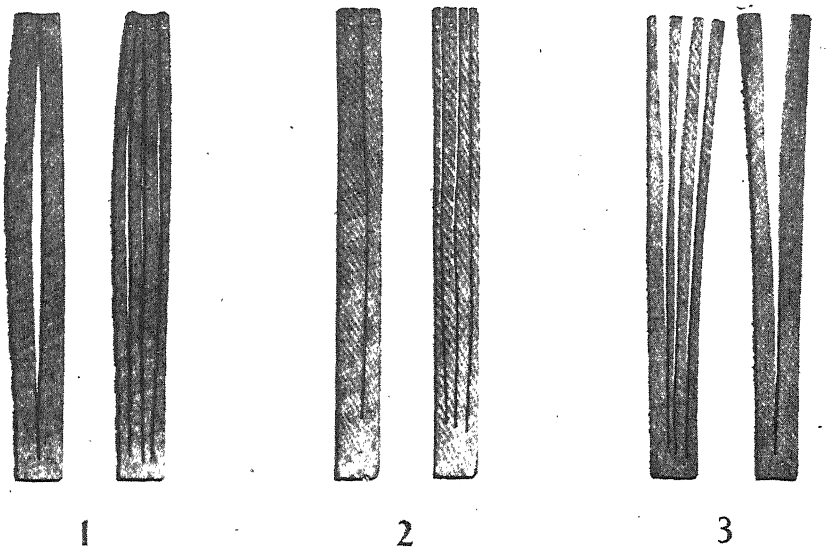


PLATE XIII.—Discs cut from test pieces towards end of seasoning run. (1) Prongs converge and pinch at free ends, indicating normal form of case-hardening. Note shrinkage of centre prongs. (2) Disc cut from same board as (1) after high humidity treatment of load. Note uniformity of kerf, denoting complete elimination of stress. (3) Prongs diverge, indicating reverse case-hardening, a rarer form than that depicted in (1).

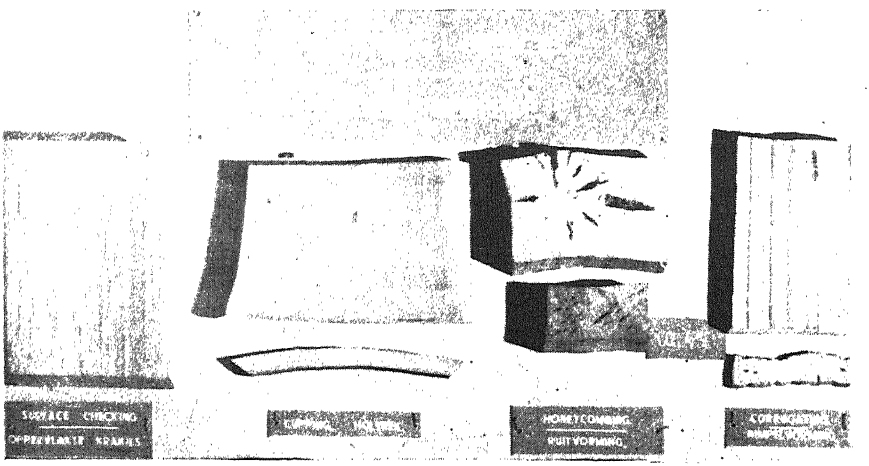


PLATE XIV.—Seasoning defects. On extreme right, board in plan and elevation, shewing association between collapse and corrugation.

When surface checked wood eventually dries the checks tend to close due to the shrinkage of the interior of the board and may not be noticed until the timber is worked up when if severe they may cause considerable loss of strength and possibly failure of the timber under stress.

Slow drying and high humidities are the only means of preventing surface checking. In air seasoning this means thinner stickers and drying under cover.

Casehardening.

Casehardening, a term which is often misapplied, is a defect only in certain cases, e.g., in wide boards which are to be planed or in any boards that are to be deep cut. The occurrence has been described under rate of drying. Time alone may relieve the stresses unless the timber is subjected to high humidity treatments in a kiln. Casehardening may be minimised by slow drying, but unless tests are cut to determine whether it is present or not, it is very often not discovered until the wood is being utilised.

Tests for casehardening are made on full cross sections of the boards, cut in the same way as the moisture content tests about one foot from the end and about $\frac{1}{2}''$ in thickness. If a cut is made in the test piece parallel to the face of the board the two halves so formed will sooner or later bend inwards if the wood is casehardened but will remain straight if the wood is free of stress. (See Plate XIII.)

Collapse.

Collapse (see Plate XII) which results in corrugations or washboarding, is quite a common defect in some of our eucalypts and has also been noted in *Pinus patula*. This is due so far as is known to strong forces exerted by surface tension when the free water is withdrawn from the cell cavities, causing the cell walls to collapse or fold in on themselves much as a rubber hot-water bottle reacts when water is emptied from it. There need not be any rupture of the wood tissue and the collapsed condition can be very largely removed by a reconditioning treatment as described under another heading.

The washboard effect may to a lesser degree be due to the uneven shrinkage of hard and soft areas of growth without the collapse of the cell walls.

Honeycombing.

Honeycombing (Plate XII) is most commonly found in wood with wide rays such as *Grevillea robusta* but is also common in some eucalypts and in stinkwood. Boards 2″ thick and over are more usually affected and there may be little or no sign of this defect on the surface or ends. This defect results from excessive stresses set up between the outer surface layers and the core of the wood while drying. It is often associated with collapse causing rupture of the ray cells which provide a plane of weakness as a result. Slow drying under milder conditions much as suggested for casehardening of which this is an advanced form is the remedy.

Discolouration.

Discolouration is a very common form of degrade in the young coniferous timbers which enter so largely into our forest economy. The

common blueing in pine is due to a fungus which lives on the food material in the wood but in itself does not damage the wood tissue as the hyphal strands pass through the natural apertures of the cell and do not penetrate its walls. Its presence is, however, a danger sign that conditions are right for other fungi which are much more dangerous.

Lack of proper drying conditions such as is experienced in the wet seasons of the years near the forests and insufficient ventilation due to inapproprite stacking are the main causes of blueing after the timber is sawn. But delay in getting logs removed from the forest may also result in severe blueing. In the latter case, as previously observed, dipping the boards in the usual solutions of Dowicide or Lignasan will not prevent its spread below the surface of the wood, though it will keep the surface comparatively bright.

The prevention of blueing therefore commences in the forest, and conversion of the tree to logs and boards in the shortest convenient time is of great importance. Once the boards are sawn from clean logs they should be dipped for a few seconds in some anti-stain solution, such as Dowicide or Lignasan, and open-stacked without delay to dry.

Blueing cannot occur in timber where the moisture content is below 20 per cent., so that once this point is reached it is safe from attack unless it should be again exposed to rain or other moisture. Full instructions for using the dips are usually supplied with the salts. Fresh solution should always be used, made up with 4 lb. of the salt to every 50 gallons of cold water. After dipping, boards should not be close piled for any length of time. After four months or so the effect of the surface coating wears off, but by this time sufficient drying has taken place to render the wood immune against the fungus.

It should be noted that the dip tends to irritate the skin and mechanical dips are therefore to be preferred to hand operation. Engine grease should be rubbed on the skin or rubber gloves used by those working in contact with the solution. The cost of dipping works out at less than 1d. per c. ft.

If the timber is to be kiln dried dipping is unnecessary, since the temperature used should kill any growth which may be present. Blueing in a kiln is a sign of improper circulation.

Notes on the More Common Timbers

The numerals placed at the end of the following notes on the characteristic behaviour of the timber of various species during drying denote the seasoning schedule, as indicated in Table V, that should be applied.

Acacia melanoxylon *(Blackwood)*. Normally dries without much trouble. The darkest wood is apt to collapse, and cross-grained material warps severely. Sapwood needs preservative treatment against *lyctus*. (3.)

Acacia mollissima *(Black wattle)*. As for *A. melanoxylon*.

Adina galpini *(Matumi)*. Needs to be dried slowly and is bumpy in thin dimensions. Easily stressed, requiring high humidity treatment at the end of run. Stickers should be closely spaced. (4.)

Apodytes dimidiata *(White Pear)*. Seasons without surface checking except in thick boards. May be very bumpy. Contains discoloured portions in logs—incipient decay—which increase drying defects. (4.)

Araucaria *spp*. All material handled had characteristic twist in grain. Thick dimensions best square piled and dried slowly. (6.)

Buxus macowani *(Cape box)*. Needs very slow drying to avoid deep surface checks. Seldom has other seasoning defects. (5.)

Calodendrum capense *(Cape Chestnut)*. Usually dries straight and even but sometimes similar to Camdeboo. (3.)

Celtis kraussiana *(Camdeboo)*. Seasons very well where grain is straight but wavy grain results in bumpy appearance of boards and loss in working up. Stickers required very close together in air or kiln seasoning. (3 or 4.)

Cryptocaria transvaalensis *(Wild Quince)*. Seasons without difficulty and varies little in physical properties. (2.)

Cryptomeria japonica *(Cryptomeria)*. Easily dried. (7.)

Cunonia capensis *(Red Els)*. The cross grain in this wood makes it difficult to dry without some warping. Surface checking is not uncommon. (4.)

Cupressus lusitanica *(Portuguese cypress)*. Inclined to check at knots. (6.)

Ekebergia capensis *(Essenhout)*. Dries easily and well with no degrade, but must be given preservative treatment as soon as dry enough, for protection against *lyctus*. Much more than the sapwood of this species seems to be attacked. (1.)

Eucalyptus cladocalyx *(Sugar gum)*. Similar in most respects to Karri but splits less. (4.)

Eucalyptus diversicolor *(Karri)*. Slow drying is essential to avoid surface checking. Use half-inch stickers in air for best results. Splitting as in *E. saligna*. Should be completed in kiln for all accurate work. (4.)

Eucalyptus fastigata *(Fastigata gum)*. Like *E. saligna* varies considerably in properties. (3 and 4.)

Eucalyptus globulus *(Blue gum)*. A very difficult wood to dry in thick dimensions on account of twisted grain, collapse and warping. Can, however, be dealt with in thin dimensions which can be reconditioned satisfactorily. (5.)

Eucalyptus maculata *(Maculata)*. One of the most satisfactory of the eucalypts to handle. Dries well but needs early protection against borers.* Air drying followed by treatment in zinc chloride solution and final kiln drying is most satisfactory for all boards containing sapwood. (3 and 4.)

Eucalyptus microcorys *(Microcorys)*. Usually casts badly, resulting in excessive waste from centre sawn boards. Also inclined to surface checking and requires slow drying as for Karri. (4.)

Eucalyptus paniculata *(Paniculata)*. Usually with low moisture content, is easily surface checked and dries very slowly. Apt to cast badly after sawing from the log. (5.)

Eucalyptus pilularis *(Pilularis)*. Tends to collapse badly even in air seasoning but responds well to reconditioning treatment. (5.)

Eucalyptus resinifera *(Resinifera)*. As for E. *microcorys*.

Eucalyptus saligna *(Saligna)*. This species varies considerably in weight but is normally very easily handled. Splitting which is severe in logs and freshly sawn boards does not appreciably increase in drying.

---

*The only eucalypt which has not shown signs of borer attack in ten years' experience is *E. pilularis*. The others are attacked in varying degrees. Note that it is only the sapwood which is eaten by the *Lyctus*, or powder post beetle.

Combination of air and kiln seasoning recommended. (1 to 3 according to weight.)

Fagara davyi *(Knobwood)*. Dries slowly. (4.)

Gonioma kamassi *(Kamassi)*. Very similar to Cape Box, but more easily discoloured. (5.)

Grevillea robusta *(Silky oak)*. Very easily honeycombed. Needs slow drying at low temperature. Preservative treatment recommended. (5.)

Heywoodia lucens *(Cape Ebony)*. Seasons slowly but well and for such a dense wood shews remarkably little surface checking. Black wood is always naturally defective. (3.)

Ilex mitis *(Wit hout)*. Should be dried soon after felling to avoid blueing. (3.)

Kiggelaria africana *(Wild Peach)*. Dries slowly and is inclined to be "bumpy." Surface splits slightly. (3.)

Ocotea bullata *(Stinkwood)*. Is apt to corrugate and collapse badly and slow preliminary air drying is always recommended. Dries fairly easily but care must be exercised to avoid honeycombing in thick sizes. Fairly high shrinkage. (5.)

Olea laurifolia *(Black Ironwood)*. Inclined to warp badly and surface check severely. Specially low temperatures and high humidities are required. (5.)

Pinus canariensis *(Canary pine)*. Somewhat difficult to dry without surface checking. Resin appears to hinder moisture movement. (6.)

Pinus caribaea *(Caribbean pine)*. As for *P. patula*.

Pinus halepensis *(Aleppo pine)*. Inclined to surface check and to warp badly. (6.)

Pinus insignis *(Insignis)*. No special difficulty in drying. In dimensions over 1½" thick square piling will reduce warping. Some centre splitting is unavoidable if cut from small trees. May require anti-stain dip but less liable to blueing than *P. patula*. (Up to 1½", No. 7; thicker boards, No. 6.)

Pinus insularis *(Insularis pine)*. As for *P. patula*.

Pinus leiophylla *(Leiophylla pine)*. As for *P. patula*.

Pinus patula *(Patula)*. Very easily dried in air or kiln but on account of its high initial moisture content liable to dry rather unevenly. Very liable to blueing and should be dipped in anti-stain solution if rapid drying cannot be assured. To minimise warping young fast grown material should not be dried at initial temperatures higher than 160°. Air seasoning stacks must be narrow and well ventilated. Rapid conversion essential. (Up to 1½", No. 7; thicker boards, No. 6.)

Pinus pinaster *(Cluster pine)*. As for *P. insignis*.

Pinus pinea *(Stone pine)*. As for *P. halepensis*.

Pinus pseudostrobus *(Pseudostrobus pine)*. As for *P. patula*.

Platylophus trifoliatus *(Wit Els)*. Tends to collapse badly. Otherwise dries well, seldom with surface checking or end splitting. (5.)

Podocarpus *spp. (Yellowwood)*. Dries rapidly and easily but inclined to stress badly due largely to compression wood areas. Needs careful final drying in kiln. (2.)

Pterocarpus angolensis *(Kiaat)*. Dries well but slowly and stresses easily. Main defect in thick material is surface splitting between sap and heartwood zones. Drying in dimension sizes prevents this to large extent. Seldom warps in drying on account of very small shrinkage. Air seasoning and final drying in kiln gives good results. (1.)

Rapanea melanophleos *(Beukenhout)*. Dries fairly well but very bumpy in centre of boards where it appears to collapse. Very easily split in logs along the wide rays. Needs rapid conversion to avoid heavy degrade. (3.)

Rhus legati *(Red Currant)*. A very difficult wood to dry satisfactorily. Dries very slowly and needs long high humidity treatment at end of run as it stresses very severely. (4.)

Sclerocarya caffra *(Maroela)*. Must be dried very rapidly to avoid blueing and mould and must be treated as soon as dry enough to prevent *lyctus* attack. Inclined to be "bumpy" and to collapse. Stickers should be closely spaced. (3.)

Spirostachys africana *(Tambooti)*. Has a very low moisture content but dries slowly. Will surface check in dimensions over 1" but otherwise behaves well. (4.)

Trichilia emetica *(Rooi Essenhout)*. Seasons well with slight defects. Preservative treatment recommended. (1.)

Vepris lanceolata *(White ironwood)*. Dries slowly. (4).

Acknowledgments

Acknowledgment is due to Mr. N. B. Eckbo, Chief Forest Products Officer, and to my colleague, Mr. John M. Turnbull, for suggestions regarding arrangement and lay-out of this paper, and to Mr. J. C. Jay, Technical Assistant, whose reliability as an operator has simplified my task in many ways.

Summary

The paper deals very briefly with the fundamental principles involved in the drying of timber and includes references to structure, moisture content and shrinkage. Mention is made of the purpose of seasoning and of the effect of the season, weather and dimensions. Various methods of determining moisture content are indicated, as well as the times taken to dry various South African species to an air dry condition under high veld conditions.

The advantages to be gained by kiln seasoning are given and followed up by a brief description of the most common types of kiln at present in use, their construction, equipment, and control.

Under control, figures are given to indicate the amount of heat, and rate of circulation required, and the object of steaming and high humidity treatment stated. Standard schedules for kiln drying are given,

Combined air and kiln seasoning is discussed and recommended for most general purposes, especially with hardwoods. A few pages are given to the reconditioning treatment of collapsed wood. The drying rate of round poles is mentioned, and is followed by a description of the usual defects met in air or kiln seasoning timber. The paper concludes with notes on the seasoning properties of the more common South African exotic and indigenous timbers, against each of which the appropriate standard kiln seasoning schedule is indicated. Numerous figures and photographs illustrate points mentioned in the text.

References

1. Eckbo, Nils B.: The Seasoning of South African-grown woods. Forest Department, Bull. No. 5, 1922.

2. TURNBULL, JOHN M.: The Pretoria Timber Seasoning Kilns. *S.A. Railways and Harbours Mag.*, Nov., 1923, Vol. 17, No. 11.
3. SCOTT, M. H.: The Saligna Gum *(Eucalyptus saligna)*. Notes on its Physical Qualities, Conversion and Uses. Forest Department Bull. No. 9, 1924.
4. ————: Notes on the Physical Properties, Conversion, Seasoning and Uses of Blue Gum *(Eucalyptus globulus)*. Forest Department Bull. No. 10.
5. ————: Notes on some Australian Timbers grown in South Africa. Bulletin prepared for British Empire Forestry Conference, 1928. Govt. Printer, Pretoria, 1928.
6. ————: Utilization notes on the more common timbers of the Union of South Africa. Department of Agriculture and Forestry. Bulletin No. 165, Pretoria. 1936.
7. ————: The Utilization of South African-grown *Eucalyptus saligna*. *Jnl. S.A. Forestry Association*, No. 4, April, 1940.
8. The Properties and Uses of South African Kiaat *(Pterocarpus angolensis)* Timber. *Jnl. S.A. Forestry Association*, No. 7, October, 1941.
9. ————: Electric Moisture in Timber Meter. *Jnl. S.A. Forestry Association*, No. 3, October, 1939.
10. THELEN, ROLF: Kiln Drying Handbook. U.S.A. Dept. Agriculture Bulletin No. 1136, Wash., 1937.

GRADING AND SAMPLING OF WATTLE BARK

By A. J. TAYLOR

(College of Agriculture, Cedara.)

THE value of wattle bark to the tanner lies mainly in its tannin content, that is, in the amount of soluble material present which can be absorbed by hides during tanning, in the process whereby hides are converted into leather. It would seem, therefore, that the most satisfactory basis for evaluation of tanning materials, such as wattle bark, would be on a basis of tannin content. Wattle extract is at present usually sold on a guaranteed minimum tannin content of 60 per cent. This can readily be done as laboratories are maintained in all the extract factories —of which there are only a few in the Union—and the composition of the product is always subject to chemical control. The product is uniform, sampling is easy and the process of analysis is simpler than in the case of wattle bark. There are, however, certain difficulties in regard to the evaluation of wattle bark on a basis of tannin content. Such points as colour as indicated by ocular examination of the bark or as determined in the infusion made from the bark, thickness, freedom from mouldiness and other general characteristics of the bark enter into its value in the eyes of the tanner or buyer. Consequently, tannin content alone is not the sole basis on which to judge a consignment.

Aspects of Grading and Sampling

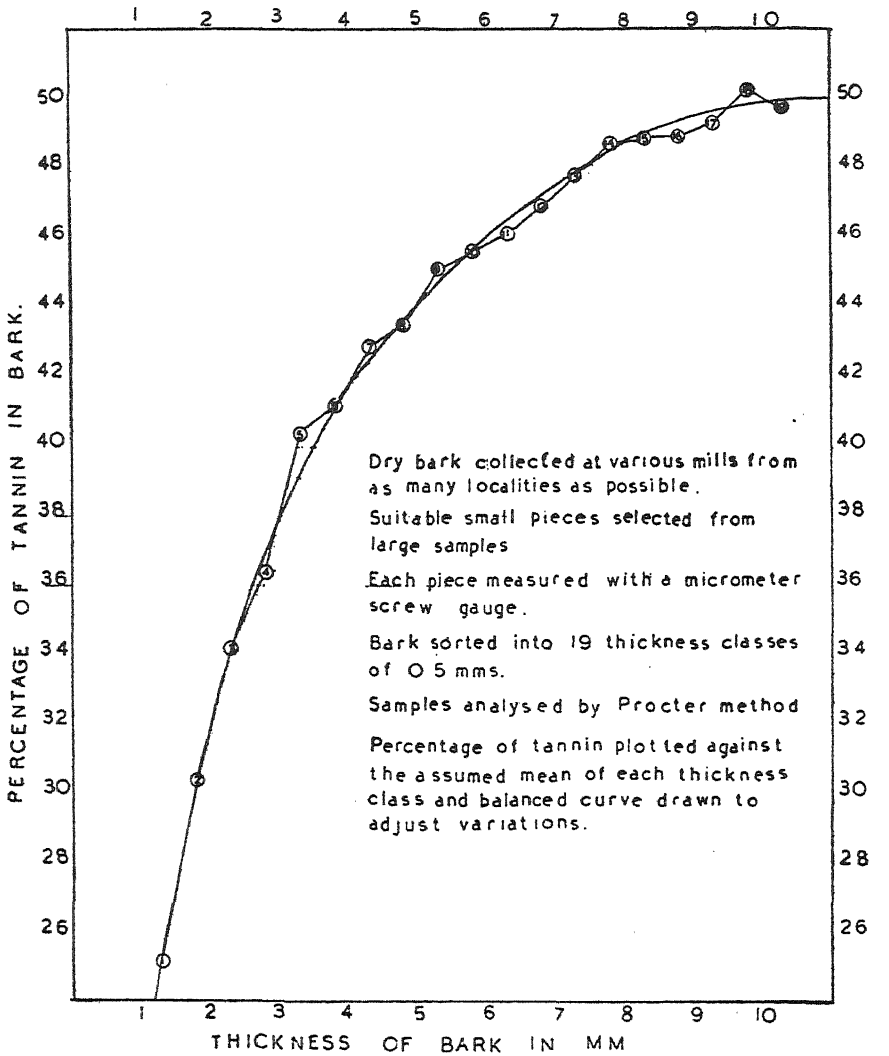
Sampling of any material always presents a problem to the chemist for his analysis is carried out on an extremely small fraction of the total bulk concerned. The first essential in any analysis is to obtain a truly representative sample and in the case of such a material as wattle bark this is not easy.

Thickness of Bark and Tannin Content.

Bark varies in thickness and in tannin content, the latter generally but not always increasing with the former. Williams (1) in his memoir on South African Tanning Materials deals with this point, his data being obtained from sections at different heights of individual trees at different ages. His samples were relatively few in number and drawn from restricted localities and the curve he obtained, whilst showing in the main a relationship between thickness and tannin content, is not a regular one. Later work carried out in conjunction with the Forest Research Officer, Pietermaritzburg, over a wider range and on a larger number of samples agreed with Williams's general findings, but also showed variations in this relationship in different areas and under different conditions. Further study on this point is required in order to obtain more precise data as to the influence of climate and soil.

In the course of his work on the grading of bark for export, the Inspector of Wattle Bark set aside a large number of clean pieces of

bark taken at random from consignments of " chopped " bark. These were measured with a micrometer screw and sorted into thickness classes of 0·5 mm. range and, when sufficient material was available to give an adequate sample, each class was analysed. The accompanying curve showing the relation between tannin content and thickness is very regular, being almost a perfect arc.



Black wattle bark. Relation of thickness to tannin content.

Commencing at 1 mm. the tannin contents at each successive mm. interval up to 4 mm. were 24, 32, 38, 41·5 per cent. respectively, ranging up to 50 at 10 mm. The fact that these samples were collected over a period of several months from mixed consignments from the

whole of the wattle-growing area meant that this work was carried out on a representative cross section of the bark produced in this country.

Variations in Bales.

Bales of " chopped " bark may contain pieces two or more inches in length and the presence or absence of a few such large pieces of thick bark in the sample drawn from a large consignment may cause considerable variations in the final results.

Individual bales in a consignment, although of the same grade may at times vary considerably in quality and in tannin content. On one occasion from two bales in such a variable consignment, the tannin content of one was found to be 35·2 per cent., whilst that of the other was 40·3.

" Ground " or shredded bark always contains some dust of a higher tannin content than the coarser portions and this is apt to be lost to a greater or less extent when the bales are opened for sampling and during he mixing of the composite sample. The tendency then is for the sample taken from bales of ground bark to be lower in tannin content than it should be unless proper precautions are taken to avoid such loss.

The technique of sampling in the mills has been improved as experience has been gained. A sail is used for the mixing of samples and a flat scoop used in sampling so as to obtain the correct proportion of dust which tends to sift through the fibrous portion of the bulk sample. The work is carried out under protection, when possible, so as to minimise loss of dust by air currents.

Prior to 1937 wattle bark had always been sold on a fair average quality (F.A.Q.) basis, inevitably a somewhat vague term. A demand arose on the part of many growers for the institution of an official Government system of grading and, to meet that demand, a Departmental Committee (2) was appointed to investigate and report on the position. This committee recommended that a system of grading of bark be adopted based on visual characters, thickness, freedom from mould and general appearance. At the same time it was recommended that samples be taken by the grader and submitted to the chemist at the College of Agriculture, Cedara, for analysis with a view to determining the range of tannin content of the various grades exported. An Inspector of Wattle Bark was appointed, whose duty it is to inspect all bark for export and to confirm or amend the grading of the mills. This work is carried out at the factory or at the docks, where samples are drawn for ocular grading and for transmission to Cedara for analysis.

Standard methods of sampling and of analysis are laid down by the International Society of Leather Trades' Chemists (3), a body whose recommendations are accepted as official in the leather world. The methods of sampling call for a random selection and opening of a definite number of packages according to the size of the consignment. This number is calculated from the formula $0{\cdot}7\sqrt{x}$, where x is the total number of packages concerned. Thus, if 1,250 bales constitute a consignment being examined by the inspector, he takes at random from the stack $0{\cdot}7\sqrt{1{,}250}$, i.e., 25 bales.

Grading Technique Adopted by Inspector of Wattle Bark.

For various reasons it was not found possible to open and mix the contents of the full number of bales—compressed bales of 200 lbs. each—called for by this formula. The time and labour involved, the general lack of facilities at the mills for such mixing and the cost to the miller of this opening and subsequent repacking of so many bales were the chief obstacles. It was therefore decided to open and examine the full number of bales called for by the formula, but only to break down a proportion of the bales opened for examination. The regulations governing the subject of grading have sanctioned this procedure and call for the breaking down of a minimum of 10 per cent. of the number of bales examined.

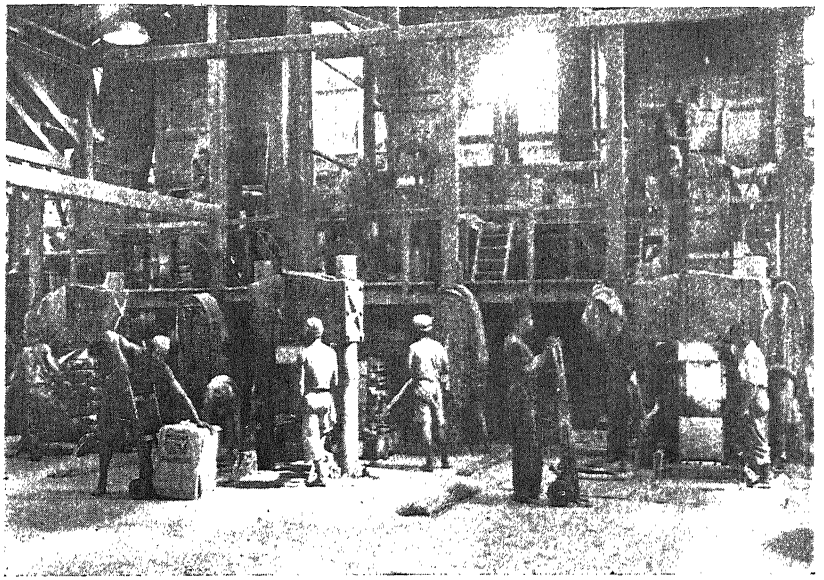
The procedure adopted by the Inspector is to open the full number of bales at the top and from one of the "edges" of each bale to break off a sufficient amount so that a total sample of about 20 lbs. is obtained. Each of the portions broken from the individual bales is examined by the Inspector who assesses the grade by ocular examination. These small portions are then mixed on a sail and a sub-sample is taken by quartering and dispatched to the chemist for analysis. At first this sub-sample was approximately a pound in weight, but this was later increased to two pounds.

Methods of Analysis.

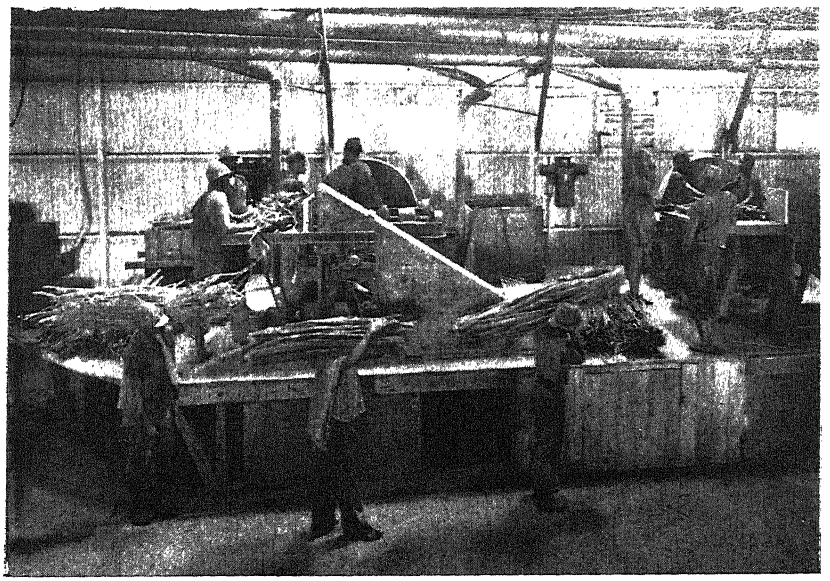
At Cedara the sample received from the grader is reduced by means of a guillotine chopper, to pieces approximately half an inch square. The sample is then thoroughly mixed and quartered until some 6 to 8 ozs. remain, which is ground in a Christy and Norris beater mill fitted with a sieve with holes one-sixteenth of an inch in diameter. The ground material is thoroughly mixed, spread out on a sheet of paper and 20 grams taken at random in small amounts for analysis in accordance with the methods of the I.S.L.T.C.

The infusion extracted by the Procter extractor from this selected sample of bark is filtered by means of Berkefeld candles. The colour of the filtered infusion is determined by the Lovibond Tintometer, B.D.H. pattern, with artificial daylight attachment. The colour is expressed in units of Red and Yellow, calculated on an infusion containing 0·5 per cent. of tanning matter. All results are reported on a 12·5 per cent. moisture content, this being approximately the moisture content of air-dry bark in Natal and a convenient figure for comparative purposes.

Recognising the variable nature of tanning materials, the difficulties of sampling and the errors inevitable in an empirical method of analysis, the I.S.L.T.C. allow a certain margin of error. Two determinations by the same analyst must not differ from each other by more than 2 per cent. or if the determinations have been carried out on the same sample by different analysts the limit is increased to 3 per cent. That is to say, two determinations on the same sample by the same analyst giving 35 or 35·7 per cent., or, if by different analysts, 35 and 36 would be accepted. This does not mean that all analyses vary to this extent; these are only the limits allowed. The need for such rather wide margins can be appreciated when it is realised that "tanning matter" is not a definite compound but is the extract obtained from



Baling wattle bark for export.



Chopping wattle bark for export.

Photos by courtesy of the Natal Tanning Extract Co.

bark under certain defined conditions of extraction and that the amount extracted may vary if temperature and time of extraction are not carefully controlled.

In the early days of grading difficulties naturally arose in regard to correlating grades with tannin content. At times considerable discrepancies between grading and analysis occurred, a position accentuated by the fact that the chemists at the different extract factories and mills employed methods suited to the requirements of their factory control but which were not those of the I.S.L.T.C. These methods differed mainly in the manner of preparing the extract or infusion for analysis and it is inevitable that variations in the results obtained from what can only be described as an empirical method must occur.

The Inspector of Wattle Bark at that time expressed the opinion that it was possible to gauge the tannin content of a large parcel of bark just as accurately by ocular examination as by analysis, basing his contention on the difficulties of sampling and the variations in results due to different methods of analysis.

It is true that the tannin content of wattle bark can be correlated to a considerable extent with thickness and general appearance, but there are so many imperfectly understood departures from such relationships that ocular examination does not always agree with the results of analysis. This fact has long been known and is referred to by C. O. Williams in his work on South African Tanning Materials. Samples analysed at Cedara during recent years have at times given unexpected results, e.g., a " prime " bark of good appearance was found to contain only 33·6 per cent. of tanning matter and an " average " bark only 30·2. At one mill, dealing with mixed bark where blending in the consignment was poor, one sample estimated to contain 35·8 per cent. of tannins was found on analysis to contain 39·9 and another estimated at 35·0 contained only 32·9 of tanning matter.

It is realised that locality and climatic conditions play a great part in these variations and in cases where the grader knows the source of the bark his estimates, after experience has been gained in grading such barks, are very reliable. A similar position is said to hold in the wattle trade in Australia, where buyers become very proficient in estimating the tannin content of bark grown in their own areas, but are less accurate when working in new and distant parts of that country.

After the initial difficulties had been overcome it must be admitted that the inspector and his staff have achieved remarkable success in estimating the tannin contents of barks graded by them. During the past two years, when forwarding samples for analysis, the estimates of tannin content have been included and subsequent chemical analysis has largely confirmed these results.

The grader's estimates and the analytical results so obtained from 576 such samples received at Cedara during the period August, 1939, to May, 1940, have been submitted to statistical analysis, with the results shewn in Table I. The agreement between the grader's estimate and the chemical analysis is extraordinary and it is fairly obvious that there are no significant differences between the figures in any of the grades.

TABLE I.

GRADER'S ESTIMATE OF TANNIN CONTENT COMPARED WITH CHEMICAL DETERMINATION.

Grade	Number of Samples.	Mean tannin content as determined by					
		Grader's inspection.			Cedara analysis.		
		Tannin per cent.	Standard deviation.		Tannin per cent.	Standard deviation.	
			Absolute.	Per cent. of mean.		Absolute.	Per cent. of mean.
C.P.	21	38·79	0·86	2·2	39·50	1·36	3·4
C.A.	212	36·46	0·81	2·2	36·50	1·43	3·8
C.M.	56	35·09	1·12	3·1	35·09	1·75	5·0
G.P.	54	37·37	0·61	1·6	37·29	1·59	4·3
G.A.	82	35·96	1·20	3·3	35·76	1·30	3·6
G.M.	151	34·09	0·92	2·7	33·66	1·24	3·7

At first the analyst was aware of the grader's estimates, but later this information was not disclosed until after the analysis had been completed. The statistical examination of the data did not disclose any difference in results between the earlier and later samples, indicating that the prior knowledge of the estimates had no effect on the analytical results.

Such proficiency in estimating the composition of barks submitted for grading has been developed by personal experience in conjunction with the subsequent analysis of the samples on which the grader's estimate was based. Greater accuracy in estimating was obtained when dealing with samples of types readily identified or samples which have been blended from different sources than in the case of consignments from unidentified sources.

Variations in Sampling.

As illustrations of the difficulty of obtaining true samples, a few cases that have arisen may be quoted. These cases occurred during the earlier days of grading and the first pair of samples in particular must be regarded as abnormal. Improvements in technique have reduced such discrepancies, but these cases were of importance as they indicated the need for investigation.

Three pairs of samples were each taken separately from the same consignment and each analysed by two analysts, with the results shewn in Table II.

TABLE II.

COMPARISON OF TWO ANALYSTS' ANALYSES.

Constituent.	Amount present in undermentioned pairs of samples as determined by analysts a and b.					
	1		2		3	
	a	b	a	b	a	b
Tannin matter	35·4	39·9	34·2	35·2	37·3	35·3
Soluble non-tannins	10·0	10·7	10·9	10·6	11·6	11·1
Reds (Lovibond units)	5·0	4·7	4·4	4·8	3·2	4·0
Yellows ,, ,,	6·0	5·4	5·5	5·7	4·2	4·4

Whilst the difference between the two samples of "2" are within the limits allowed by the I.S.L.T.C. for two analysts, the discrepancies in

the other cases are much greater and indicated the need for initiating work on the problem of sampling.

Development of Sampling Technique

Some 600 analyses of samples of bark were undertaken in order to develop a more scientific technique than that already described for the sampling of consignments of wattle bark. The results are summarised in the following paragraphs. Details of analytical data, statistical operations, etc., can be obtained on application from either the Principal, College of Agriculture, Cedara, Natal, or the Chief, Division of Chemical Services, Private Bag, Pretoria.

Variations Between Samples Taken from a Bulk Sample Without Prior Chopping.

All the portions of bark selected for grading a consignment of chopped average bark, considered to exhibit average variability, were well mixed on a sail into a single heap. From this bulk sample twelve sub-samples of approximately 1 lb. were drawn, the heap being remixed thoroughly prior to each sub-sample being taken.

A consignment of ground average bark was also sampled in the same way. All samples were analysed by two analysts.

Statistical analysis of the data show that:

(1) Analysts do not differ significantly but that significant differences exist between samples.

(2) Samples of chopped average bark are subject to greater variation than samples of ground bark, differences between samples being significant in both cases.

(3) Samples collected from the same heap by one operator were significantly different from those collected by another operator, the two operators taking heir samples alternately.

(4) Sampling variance is reflected more intensely in tannin content than in soluble non-tan-content, and hence in subsequent studies statistical analysis of soluble non-tan figures was omitted.

From a consideration of the facts enumerated this technique for extracting a 1 lb. sample from a bulk sample is considered inadequate.

Variations Between Bulk Samples Taken from a Consignment for Export (with Prior Chopping).

The number of bales prescribed by the formula $0{\cdot}7\sqrt{x}$ required for grading were selected from a consignment of chopped average bark and a bulk sample drawn in the usual way. The bales were sewn up, replaced in the stack and the whole procedure repeated until ten such bulk samples had been taken. The selection of bales for successive bulk samples was carried out irrespective of whether the bales had been opened previously or not. In all, 220 bales were opened, 30 of these having been opened a second time.

The bulk samples were then chopped up, allowing no pieces of bark larger than approximately half-an-inch square, thoroughly mixed, and a duplicate series of two sub-samples of about 1 lb. were taken from each of the ten bulk samples. These two sets of sub-samples were analysed in triplicate by two analysts with the following results:

(1) There were no significant differences between either the two sets of samples or between any of the individual samples.

(2) A significant difference was established between the two analysts. For all practical purposes, however, this difference need not be considered seriously, the two means of 60 determinations each being 36·8 and 37·0 per cent. tans respectively.

These investigations not only confirm the validity of the $0{\cdot}7\sqrt{x}$ formula, but also prove that a fully representative 1 lb. sub-sample can be drawn from a bulk sample, provided chopping to a minimum of half-an-inch square is resorted to prior to sub-sampling. The latter issue was subsequently confirmed by the analysis of a further ten 1 lb. samples drawn from a single heap of finely chopped bark.

Variations Between Sub-Samples Taken in Different Sizes.

Three bales from a consignment of uniformly chopped average bark were broken up and thoroughly mixed on a sail and quartered to give two heaps of approximately 140 lb. each. Ten 5 lb. samples were drawn from the one heap in the manner already described, the heap being well mixed after the taking of each sample. Similarly ten 2 lb. samples were drawn from the other heap. Subsequently a series of ten 1 lb. samples were drawn from the residue after these had again been thoroughly mixed and quartered to a single heap of about 40 lb. All these operations were repeated on bark obtained from a consignment of less uniformly chopped average bark.

As before these 60 samples were chopped finely, ground and analysed in duplicate by two analysts. The following results were obtained:

(1) Significant differences were established between the three sizes of samples.

(2) Variations between tannin contents were least in the 5 lb. samples and greatest in the 1 lb. samples.

(3) For uniformly chopped average bark the standard deviation of tannin content expressed as a percentage of the general mean for 5 lb. samples was found to be 1·7 as compared with 2·7 and 3·0 for 2 lb. and 1 lb. samples respectively. For a less uniformly chopped average bark corresponding standard deviations were 2·3, 3·2 and 2·7 for 5, 2 and 1 lb. samples.

From this experiment it is evident that the 5 lb. sample is more representative of the bulk sample than either the 2 lb. or 1 lb. sample.

Summary

(1) Methods of grading consignments of bark for export and methods of drawing samples for chemical analysis from these consignments discussed.

(2) The correlation between thickness of bark and tannin content is discussed.

(3) A large or bulk sample of approximately 20 lb. weight and fully representative of any consignment of x bales of chopped bark can be extracted from the consignment by selecting at random $0{\cdot}7\sqrt{x}$ bales and drawing from these the necessary quantities to make up the bulk sample.

(4) Fully representative sub-samples of 1 lb. for laboratory investigation can be obtained from bulk samples of 20 lb. or more on condition that the whole of the bulk sample be broken down to at least half-inch mesh before quartering.

(5) Without any preliminary breaking down fairly representative samples of 5 lb. can be obtained by quartering down the bulk sample. Further quartering to 2 lb. and 1 lb. quantities results in less representative sub-samples.

(6) Differences between analysts throughout these investigations were negligible compared with differences between samples.

Acknowledgments

The compiler wishes to acknowledge with thanks reports and information furnished by the following officers of the Department of Agriculture and Forestry, all of whom co-operated in the investigations described in this paper.

Division of Forestry: E. A. Goodwin, M.A.; D. M. Grey, B.Sc.

College of Agriculture, Cedara: F. N. Battenhaussen, Ph.D. (the late); J. G. Brevis, B.Sc.; E. W. Brink, B.Sc.; H. Vorster, B.Sc.

Division of Chemical Services: J. van Garderen, M.Sc., A.I.C.; E. Fischer, M.Sc.

References

1. Williams, C. O.: South African Tanning Materials, Part I, page 21. Science Bulletin 63, 1928.
2. Grading and Marketing of Bark. Report of Departmental Committee. Dept of Agr. & For., Union of S.A., 1936.
3. International Society of Leather Trades' Chemists. Official Methods of Analysis, 1938.

A PRELIMINARY INVESTIGATION INTO THE CAUSES OF TORSION IN PINE STEMS

By JOHN M. TURNBULL

(Senior Forest Products Officer.)

DENSITY in the wood of certain South African grown pine species has been found to be a very close relative measure of bending strength (1), so close, indeed, that any degrade in quality at a constant moisture content is quantitatively reflected in the value of the expression:—

$$MR/SG^{x}$$

where MR = Modulus of rupture.
SG = True specific gravity.
x = A constant exponent.

In actual practice, x, in respect of clear straight-grained wood, has been found to approximate 1·25, and the whole expression, 28,000. Any negative deviation from this value in those species, expressed as a percentage thereof, will reflect the strength of wood yielding such lower value, relative to that of clear, straight-grained wood.

A series of static bending tests carried out at the Forest Products Institute on 642 specimens derived from the butt logs of 16 twenty-two year old stems of *Pinus pseudostrobus*, obtained from Woodbush Plantation, Transvaal, yielded the value for $MR/SG^{1.25}$ indicated in Table I. (For convenience these values will be referred to hereafter as "strength ratios.") The wood in all specimens was clear, but no specimen was rejected on account of spirality of grain. Column 6 reflects mean ratios, and columns 7 to 18, the comparative frequency of occurrence in each stem of the whole relevant range of ratios. Each variation in ratio represents a variation in weight-for-weight strength. Only three stems averaged the normal of 28,000 or more. Certain stems yielded wood quite distinct from each other in nature. Compare stems 15 and 16, for instance, with numbers 1, 2 and 3. Stems 1 and 16 have only one ratio group in common. In 1, it is a minimum, and in 16, a maximum.

The degrade responsible for the generally low ratio disclosed—an average of 26,800—is attributed by the writer to spirality of grain. Spiral grain is a form of cross-grain caused by the fibres assuming a position tangentially inclined in a given direction to the stem axis, giving rise to what is known as torsional stem development. On planed tangential surfaces its direction and intensity is revealed by the interception of the resin canals with the surface. It should not be confused with diagonal grain, usually an accident in manufacture, or when occurring locally, the effect of distortion in the region surrounding large knots. Here the fibres are inclined radially to the axis of the piece, and according to the direction of their inclination, spirality is either masked or accentuated. In this investigation any specimens shewing diagonal grain were accordingly discarded.

TABLE I.

MODULUS OF RUPTURE/SPECIFIC GRAVITY RATIO (STRENGTH RATIO) OF 16 STEMS.

Stem No.	Dbh. Ins.	Number of tests.	Specific gravity.	Modulus of rupture. 100's.	Strength ratio (1000's).												
					Mean	Number of specimens per cent. conforming to undermentioned ratios.											
						Less than 23	23	24	25	26	27	28	29	30	31	32	32
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	10	22	·443	110	30·0	–	–	–	–	–	–	9	27	27	18	14	5
2	12	16	·440	106	29·5	–	6	–	–	–	6	6	19	19	38	–	6
3	14	28	·422	97	28·5	–	–	–	–	–	21	29	32	14	4	–	–
4	13	48	·450	102	27·5	4	4	6	4	17	27	23	13	2	–	–	–
5	12	17	·479	110	27·5	–	–	–	–	29	12	41	12	6	–	–	–
6	14	30	·445	100	27·5	–	3	3	–	20	27	17	20	7	–	3	–
7	11	45	·433	96	27·3	–	2	5	7	27	13	20	11	7	4	4	–
8	16	51	·444	98	27·1	3	–	3	14	11	21	19	16	10	–	3	–
9	16	50	·428	91	26·9	4	8	4	4	20	10	24	16	6	2	2	–
10	14	47	·483	108	26·7	11	–	9	4	6	27	17	13	11	2	–	–
11	13	35	·432	94	26·6	6	3	6	9	6	19	22	17	6	3	–	3
12	15	42	·430	93	26·3	5	5	5	7	17	20	22	17	2	–	–	–
13	14	30	·507	112	26·2	7	10	3	13	13	20	17	17	–	–	–	–
14	17	67	·422	88	25·8	4	10	10	9	31	20	6	7	3	–	–	–
15	15	50	·409	77	23·8	34	2	12	10	16	10	10	6	–	–	–	–
16	20	79	·433	78	22·2	45	14	11	15	6	4	5	–	–	–	–	–
All	14	642	·443	98	26·8	7	4	5	6	13	15	18	16	8	5	2	1

In stems 8 and 16, fibre inclination in 87 specimens was measured and recorded against the strength ratio of each as determined by test. The results will be seen in Table II. The mean fibre inclination of all

TABLE II.

SPIRALITY AND STRENGTH RATIOS OF 87 SPECIMENS.

Spirality. (One in undermentioned classes.)	Number of tests.	Strength ratio. 1000's.	Strength relative to normal.
Up to 5·0	10	18·0	·64
5·5 to 7·5	23	22·0	·79
8·0 to 10·0	20	25·0	·89
10·5 to 12·5	12	26·0	·93
13·0 to 15·0	8	27·0	·97
15·5 to 17·5	6	27·5	·98
18·0 to 20·0	3	30·0	1·07
20·5 to 22·5	3	29·0	1·04
Over 22·5	2	28·0	1·00

TABLE III.

MEAN SPIRALITY AND STRENGTH RATIOS OF TWO STEMS.

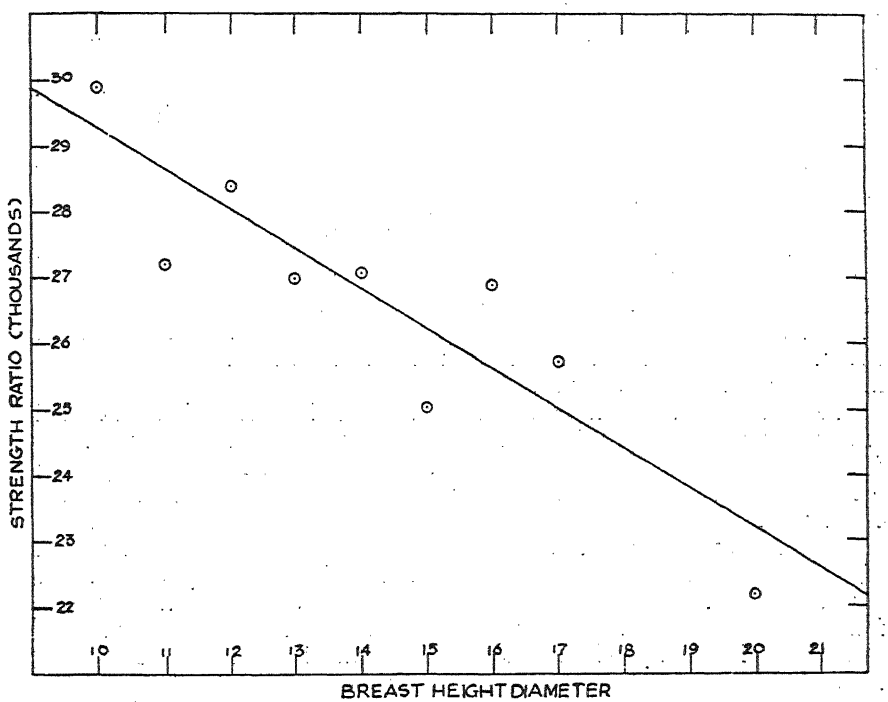
Stem No.	Number of tests.	Mean values for	
		Fibre inclination. One in undermentioned	Strength ratio.
8	51	14·0	27·1
16	79	7·5	22·2

specimens tested in each of these two stems individually, together with their mean strength ratios are reflected in Table III, from which it will be seen that the differentiation between the weight-for-weight strength of the two logs is in close conformity with the pooled equivalents shewn in Table II. It was accordingly assumed that in this shipment at least, strength ratios of test specimens were a relative measure of fibre inclination, so that the mean ratios of each of the 16 stems should reflect approximately their relative mean fibre inclination. Granted this, any correlation that may exist between spirality and yet a third characteristic of the trees should be detectable in the correlation between strength ratio and that third characteristic. There is a distinct inverse correlation between the mean strength ratios of the 16 stems and their breast height diameters. Amongst individual stems the coefficient is ·49, and between groups as arranged in Table IV, ·81. Plotting actual ratios given against their respective dbh's, as in the accompanying figure, and converting the ratios read off against successive dbh's to a decimal of the normal of 28,000, some idea of the degrade due to spirality associated with varying rates of growth may be obtained. In the final column of Table IV values complementary to normality, thus representing actual degrade, are shewn. Positive degrades shewn are in themselves small,

TABLE IV.

DEGRADE DUE TO SPIRALITY ASSOCIATED WITH VARYING RATES OF GROWTH.

Dbh. Ins.	Number of stems tested.	Strength ratio.		Corresponding degrade per cent.
		Actual.	Graphed values.	
10	1	30·0	29·2	—
11	1	27·3	28·6	—
12	2	28·5	28·0	—
13	2	27·1	27·4	2
14	4	27·2	26·8	4
15	2	25·1	26·2	6
16	2	27·0	25·6	9
17	1	25·8	25·0	11
18	–	——	24·4	13
19	–	——	23·8	15
20	1	22·2	23·2	17



Strength ratio/diameter relationship.

but it must be borne in mind that they are referable to a constant specific gravity. To ascertain absolute inferiority in strength, their deviation from 100 must be multiplied by the ratio borne between actual and average specific gravity. Thus, the average specific gravity for this shipment of pines was ·443. A 17 inch stem averaging say, ·380,

would therefore fall short in strength of the normal by ·380/·443 × ·89, or ·76. As far as this stand of *P. pseudostrobus* is concerned, however, quite a high rate of growth would seem to be associated with scarcely significant degrade.

From the foregoing there would seem to be strong indirect evidence that spirality in even-aged stems grown on a uniform site varies directly with rate of growth. Such behaviour is quite in keeping with the difference in reaction to espacement between height and radial growth. The latter reaction is preponderantly greater than the former. Provided the overlap between the fibres of successive tiers is constant, total height of stem should be determined by aggregate fibre length. Where their axes are inclined, however, effective fibre length would be reduced in a ratio equal to the cosine of the mean angle of inclination, and their aggregate length would thus be curtailed disproportionately to radial development.

Büsgen (2) states that " torsion of the fibres is congenital, as is shewn by a small experiment in the Tharandt nursery," and in this is supported by Champion (3). Comparison of the wood of even-aged stems of varying diameters on one site may yield information regarding the influence of rate of growth, although not necessarily as determined by espacement. Diameter distribution among even-aged trees in a single stand is no doubt mainly genetic, marked variations from a peak frequency group signalising the prevalence of genetic sports. Direct correlation of a measurable character, such as spirality with diameter, however, suggests an inherent capacity amongst rapidly growing strains for the production of spirally grained stems. This does not necessarily eliminate the possibility of environmental influences such as gaps left in early thinnings, or intensively localised edaphic variations. Further investigation in this matter should accordingly proceed along two lines, environmental and genetic. The former might consist of measurement of fibre inclination in stems of two or more species each from two or more localities, and from at least two well differentiated even-aged size classes in each locality. The genetic investigation might be divided into two parts: general and specific.

The general genetic investigation, aimed at detection of an external characteristic that might be associated with spirality, might be on the following lines. Felling of 50 stems in the same stand at Graskop from which material for the present study was obtained. Cones from each of these trees to be separately collected and carefully stored pending examination of logs cut from the trees. One or more logs from each of the 50 stems to be examined, and the degree of spirality noted against each tree. Seed from the three trees exhibiting highest and from the three shewing lowest spirality, to be separately sown, and transplants from each of these six stocks planted out in due course on six separate one-tenth acre plots at an espacement of 6′ × 6′. When two or three years old, the trees thus raised to be examined with a view to detection of any external characteristic that might be associated with the degree of spirality exhibited by the respective parent trees. It is for the geneticist to determine whether in such an experiment precautions should be taken against cross-pollination.

The specific investigation would consist in confirming whether the external characteristic concerned is actually rate of growth, that is, in even-aged stands, size. This would merely entail spirality measurements on stems of differing diameter procured from selected even-aged stands—more or less replication of the present investigation, but involving direct measurement of spirality instead of strength ratio. Positive results from this investigation would short-circuit the general investigation, which might then be abandoned.

Summary

A significant inter-correlation detected in 16 even-aged stems of *Pinus pseudostrobus* raised on one uniform site between degree of torsion, breast height diameter and the ratio that exists between modulus of rupture and specific gravity raised to a given power, suggests that torsion is directly associated in some way—not necessarily sylvicultural—with rate of growth. Lines on which further investigation into this matter might be pursued are discussed.

References

1. Turnbull, John M.: The Relationship between Modulus of Rupture and Weight in South African Grown Pine Timber. *Jnl. S.A. For. Assn.* Issue 7, Oct., 1941.
2. Büsgen<Munch<Thompson: The Structure and Life of Forest Trees. London, Chapman, and Hall, 1929. p. 98.
3. Champion, H. G.: Contributions towards a Knowledge of Twisted Fibre in Trees. Indian Forest Records, Silvicultural Series. Calcutta. Vol. II, Part 2, 1925.

KORRESPONDENSIE
CORRESPONDENCE

THE VALUE OF AN IMMATURE PLANTATION

To the EDITOR

Sir,

In his reply to my letter in your last issue (No. 7), Mr. O'Connor insists on the validity of assessment based on expectation value. Neither he nor I, apparently, can produce any exact analogy from other industrial spheres, and a deadlock has accordingly arisen which only legal opinion informed by actuarial evidence can loosen. The question resolves itself into a consideration of the legality of a claim for the present value of an anticipated profit unsecured by contract. Has the Association no means of obtaining legal opinion in the matter?

As regards the part played in the matter by the land, which Mr. O'Connor suggests is nil, it is surely obvious that any merchantable yield of wood that claimant might expect to recover could be realised only through its productivity. If his land lacked productivity, his anticipated profit would never be realised. Were it actually productive he would have been deprived of its effective value for four years, and this, at least, with interest, he would be entitled to claim. This would be an actual loss; the expectation of the crop, in my opinion, although not in that of the Court or of the litigants, merely a problematical one.

It is remarkable that Schlich does not attempt to apply his principles of forest valuation to the assessment of damages affecting immature forests. This is a serious omission in the financial section of his Vol. iii, in which he appears to be concerned only with the profitability of forestry when maturing of the crop is assured. His discussion of premature values is seemingly intended merely for the guidance of intending buyers and sellers, and has not necessarily any legal value. How, indeed, could it have? Supposing an investor is dissatisfied with a return of 5 per cent. from an investment, and is told by an expert that the purchase and the planting up of a piece of land with *Pinus insignis* will shew after 30 years a mean forest per cent. of 10. Suppose he persuades another investor to sell out a security yielding 7 per cent. and to take a half-interest in the venture. Suppose, finally, the crop established is burnt out 10 years after establishment; the losses incurred by the two parties would differ by the difference in interest at 5 and 7 per cent; yet no Court would take cognisance of any differentiation in the claims of the two parties.

This is not a parallel to the case presented by Mr. O'Connor, but is instanced to illustrate the difference between the advisory and legal incidence of well-known principles of forest valuation. Mr. O'Connor would no doubt base a claim on the partnership expenditure compounded at 10 per cent. interest, which, if conceded, would no doubt please both parties. A magistrate or a superior Court might award damages on the same basis, but that would not establish the justice of the award.

Yours faithfully,

LAIRD.

In reply to "Laird's" question regarding the possibility of obtaining legal opinion on this subject, we are able to state that the entire dossier has been informally submitted for opinion to an eminent legal well-wisher of the Association, who endorses the legal opinion quoted in "N. L. K.'s" letter that now follows:

To the EDITOR

Sir,

I do not question the equity of Mr. O'Connor's contention, but I think he is unduly optimistic in imagining that the case would have been settled in the manner indicated. The probabilities are that it would have proceeded somewhat as follows:

Magistrate: That is very interesting Mr. A., but tell me, is it not the case that despite similarity in soil and climatic factors, no two plantations are exactly alike?

Mr. A.: Yes.

Magistrate: Is it not also the case that costs of establishment may vary with soil conditions and labourers' rates of pay?

Mr. A.: Yes.

Magistrate: Is it not possible that by the time the Plaintiff's plantation reached maturity the price of mining timbers might have changed?

Mr. A.: Yes.

Magistrate: There is also the possibility that the plantation may have been destroyed or damaged by insects, fungus or climatic agencies?

Mr. A.: Yes.

Magistrate: What I have been leading up to is that it is not possible to determine the rate of interest the plaintiff's plantation would have earned until *after* the realisation of the crop?

Mr. A.: That is so.

Magistrate: Then the rate of interest you arrived at may not be applicable to the case before us?

Mr. A.: No.

Magistrate: The matter would become much more difficult if we were dealing with a pine plantation which takes from 30 to 40 years to mature instead of a gum plantation managed under a rotation of 8 years?

Mr. A.: Yes.

Magistrate: My difficulty is that I am asked to award damages on the basis of a problematic future value which in turn is based on figures obtained from another plantation and which may not be applicable to the case before me. What do you suggest?

Mr. A: I submit that it would be more equitable to award damages on the basis suggested by me instead of on cost value plus a reasonable rate of interest plus cost of re-establishment.

Magistrate: Thank you. The case will be adjourned and judgment given this day week.

The following are the views of a legal practitioner, who wishes to remain anonymous:

"The method of valuing an immature plantation must, in the first place, have regard to the ultimate value, but after certain factors are considered, in the case of a very young plantation, the value will work down almost to replacement value.

"It is felt that the problem should be approached in much the same manner as an actuary or the Courts would consider the case of a widow who claims compensation by reason of the death of her husband through

another's negligence. In such a case one requires to arrive at a figure that will represent what the widow would have received from the deceased's earnings during the period of his earning life. In ascertaining this figure some questions of considerable nicety have often to be decided upon—of considerably more difficulty than to decide what a given forest on maturity would be worth.

"Assuming now that the deceased earned £500 per annum without the prospect of increase, of which the widow received £200, she would have to be granted *now* a lump sum that would entitle her to payments of £200 per annum for the remainder of the earning period (say, 65 years), at the end of which time the capital would be exhausted. This sum corresponds to our value of the forest on maturity, less a percentage for present payment which will be dealt with later.

"But the sum set out above—assume £3,000—is not the end of the matter, and the Defendant, in the case of the human being, is entitled to the advantage of certain deductions, varying in each case, such as:

(a) The occupation of the deceased. A bigger deduction would be made in the case of a flying instructor than in the case of an attorney, for instance.

(b) What are the widow's chances of re-marriage? A bigger deduction would be made in the case of a young attractive widow without a family than in the case of one with a family or an older or less attractive woman.

(c) The benefits received immediately from life or accident policies.

(d) The woman's state of health. The defendant is entitled to a deduction in the case of a frail or unhealthy woman and possibly none in the case of a robust widow.

"This broadly covers the human case and common sense tells one that the case of the forest should be dealt with on the same lines.

"If we take the case of a forest maturing at 10 years and the value at maturity £100 (speaking in round figures) we would probably approach the problem, when dealing with forests planted, say, 2 and 8 years ago,

	8 yrs.	2 yrs.
(a) Risk from fire. We must take into consideration whether fires are frequent or rare, proximity to a railway line and so on. Percentage deduction based on years, say	2%	8%
(b) Drought, also depending on the locality, average rainfall and so on, and the fact that the younger trees are (probably) more likely to be affected by drought than the older ones	2%	20%
(c) Insects and pests. Again (probably—not being an expert on forestry matters) the young trees are far more likely to be affected than the older ones	3%	30%
(d) There might be other deductions but a proper and further deduction should certainly be made for the fact that the plantation owner will be paid at the present time instead of at maturity of the forest (the only real point of the judgment). This figure would have to be worked out at compound interest rates		

and we may assume	6%	12%
(e) There is another small factor—the plantation owner will start a new forest two years earlier than he expected and reap an earlier future benefit in each case. Something must be allowed for this, say	3%	3%
(f) There are probably other factors — my percentages are probably quite erroneous, but we may probably assume	4%	7%
	20%	80%

"Thus, taking the matter generally, it is considered that the above should fairly represent the proper method of arriving at the value of an immature plantation. The owner of the 8 year plantation would be entitled to a judgment for £80 and the other to a judgment for £20 (or probably less)."

Yours faithfully,

N. L. K.

Mr. O'Connor's comments on the preceding letters follow.

The points raised in Laird's letter that I have to answer seem to be those referring to the part the land plays in the valuation of a young plantation. Let me do so in parable.

A farmer was sitting on his stoep in great content, contemplating the fine crop of mealies he had raised. His neighbour came up and asked what he expected to get for the crop and was told that it had already been sold for £500. The neighbour remarked that if he had put the ground under potatoes he might have realised £1,000, whereupon the farmer burst into tears because he had lost £500. He refused to be comforted until his wife pointed out that if he had let the ground for grazing he could not have expected to get more than £50. "Come," said the farmer, "this is not so bad, instead of losing £500, I have made £450." After a little while it struck him that in any case he could not have let the grazing and therefore, after all, he made £500. He therefore regained in full the content with which he was contemplating his venture. His son then came to him and reminded him he had to pay £100 interest on a loan raised on the ground and remarked that the mealie crop had therefore earned for his father only £400. The farmer had by now become suspicious of all attempts to minimise the value of his mealie growing venture. After pointing out that, even if he had to pay £1,000 interest, the mealie crop was still worth £500 and that he was that much to the good, he told his neighbour and his wife and his son to go away and not worry him with silly arguments.

Mr. King questions the validity of basing calculations on the future value of the crop, but his point is really irrelevant to the object of the arguments advanced in my original contribution, which was to establish an intermediate value when the initial cost and final value were known and accepted. However, in my original contribution I showed the absurdity of arriving at an intermediate value by taking merely the cost plus interest at current rates. As far as I can see, the future value, even if it is only a possibility, *must* be taken into account and the onus of

suggesting some better basis rests on those who disagree with me on the point.

It is to be noted that in the calculations submitted by the legal practitioner he does definitely assume a final future value for a plantation from which he arrives at values which can be assigned to it at earlier ages. His final value (presumably net, after deducting cost of establishment) is £100 at 10 years. His system of calculations for the intermediate values may easily lead to results that, on the face of them, can be disputed—at least as far as plantations are concerned. The example worked out gives a value of £20 at 2 years and £80 at 8 years. In other words the rise in value is in a straight line at the rate of £10 per year. Now no forester will accept that the value of a plantation rises in this way, in view of the risks to which the development of the plantation is exposed—the very risks which our legal friend tried to allow for. At the beginning the risk has to be faced for the whole of the rotation, but, with advancing age, it becomes less (operates for a shorter period) until it disappears when the plantation is mature. Consequently, the rise in value must, in youth, be slow, but it can increase more and more rapidly as maturity is approached.

Now if the diagram which accompanied my original contribution be examined, it will be seen that the line representing what I consider to be the true values at intermediate points between the beginning and end of the plantation, behaves exactly as it should to allow for the different degree of risk to be faced at different periods.

I accept the line *not* because it is determined by a compound interest formula (for I, like the legal practitioner, see no compulsion to bring interest into the calculation at all), but I adopt the compound interest formula because it gives systematic form to a line representing values I can accept. That it also satisfies those who think that compound interest must enter into the calculations somewhere is all to the good.

TAALFOUTE

Aan die REDAKTEUR

Meneer,

Dit spyt my om die volgende onder u aandag te bring.

In die jongste tydskrif van die vereniging verskyn die verslag van die derde jaarlikse algemene vergadering in beide Engels en Afrikaans. Dit blyk of die verslag oorspronklik in Engels opgestel is en daarna vertaal is in Afrikaans.

Hoe dit ook al sy, die Afrikaanse verslag is deurspek van foute. Sommige paragrawe is totaal onverstaanbaar, bv. die paragraaf beginnende met ,,Wat inheemse bosse betref . . .''

Daar verskyn foute soos: (Ek skrywe die foutiewe woord in drukletters) ,,*personele* pogings,'' instede van ,,persoonlike pogings,'' ,,Mnr. Loock *behulp*'' instede van ,,behulpsaam,'' ens. ens., ,,*kopies*'' instede van Kopieë.

Ek kan u nog talle ander foute noem maar dis onnodig.

Ek soek nie na die taal-suiwerheid wat in 'n Tydskrif vir Taal en Lettere tuishoort nie maar wanneer Afrikaans op so'n wyse gebesig word is dit genoeg om die gewone leek se protes uit te lok.

Die uwe,

,,BOM.''

REVIEWS

FORESTS AND EROSION. By *Professor E. P. Stebbing*. Reprinted from the *Journal of the Royal African Society*. January, 1941.

Professor Stebbing suggests that had the wide-spread deforestation that had taken place in Britain during earlier centuries been accomplished under less kindly climatic conditions her administrators might have foreseen the menace of land deterioration attendant on indiscriminate deforestation in her tropical dependencies. This is really the underlying cause of the ignorance to which we now attribute such deterioration, but being a more fundamental conception one wonders whether its application may not be widened to enable man to anticipate evils ensuing from transformations in other spheres of development. The advance of the man-made desert in many parts of the world is to-day a matter of general knowledge. Up to little more than a generation ago, however, the phenomenon, and more particularly any consideration of its causes, were as foreign to the mind of the embryo colonial administrator as the idea of depth would be to the mind of a dweller in a two-dimensional world. We are continually being told that the old order changeth, but take no heed until its halo or its horns, whichever the case may be, appear. Who, hardly more than 10 years ago, would have dreamt of the deliberate jettisoning by powerful civilized nations of a centuries-old ethical code? Retrogressive change can only be stemmed at its source by the cultivation of awareness.

Of more immediate potential causes of land violation, Professor Stebbing, as is his wont, points with unerring finger at one: release for military service of colonial forest officers without compensatory recruitment or, it may be assumed, re-employment of experienced pensioners. In Kenya, the trained forestry staff has in this way from 24 professional officers been reduced to 9 and, according to the author, "any other of the half-dozen Forest Departments in Africa is in the same position." The latter statement is somewhat surprising in view of the fact that the war has never, as in Kenya, either crossed or reached the frontiers of some of these other colonies. The author points out that the demands of the armies in the Middle East for timber from these regions will entail heavy extra fellings, which, unless conducted under ample expert supervision, will result in further depreciation in the growing stock of forest areas that have already attained a dangerously low level, and ultimately in widespread and irremediable soil erosion. Many types of forest in these regions may be said to bring their own soil with them in their evolutionary succession and to take it with them when they go.

The whole paper forms a short survey of the effects of deforestation in British Africa, with a glance at Palestine and the West Indies, from which the author concludes that the direct bearing of the forest area upon erosion is not yet fully understood. The fact that these colonies

happen to be independently governed is an unfortunate accident but as his conclusion " applies with equal force to the rest of Africa," he urges consideration of the general problem as it affects the greater part of the Continent by a small international committee.

Although not expressly stated, the author seems to have been actuated in writing this paper by the presence in Britain at the time, on various missions, of representatives of French Equatorial Africa and the Belgian Congo, thus providing a unique opportunity for discussion of the main lines of co-operative attack against a most serious impending menace.

PUBLICATIONS RECEIVED

Receipt of the following publications is acknowledged with thanks:

ANNUAL REPORT OF THE DIVISION OF FORESTRY for the year ended 31st March, 1941.

CANADIAN RESOURCES BULLETIN. No. 231, September, 1941.
No. 242, November, 1941.

EMPIRE FORESTRY JOURNAL, THE. Vol. 20, No. 2, 1941.

GAS PRODUCERS FOR MOTOR VEHICLES AND THEIR OPERATION WITH FOREST FUELS. By I. Kissin. Imperial Forestry Bureau Tech. Bull. No. 1. Oxford, 1942.

SCOTTISH FORESTRY JOURNAL, THE. Vol. 55, Part 2. October, 1941.

TRANSPIRATION OF DIFFERENT PLANT ASSOCIATIONS IN SOUTH AFRICA, THE. Part 1—Transpiration of Karoo Bushes. By M. Henrici. Dept. of Agriculture and Forestry Tech. Bull. No. 185. Pretoria, 1940.

The

Journal of the South African Forestry Association

October

PUBLISHED BY THE ASSOCIATION
April and October

Die

Tydskrif van die Suid-Afrikaanse Bosbouvereniging

Oktober

UITGEGEE DEUR DIE VERENIGING
April en Oktober

No. 9. 1942
PRETORIA
6/-

SOUTH AFRICAN FORESTRY ASSOCIATION.

Patron:

HIS EXCELLENCY THE GOVERNOR-GENERAL,
THE RIGHT HON. SIR PATRICK DUNCAN, G.C.M.G., K.C.

President:

COLONEL THE HONOURABLE DENEYS REITZ, M.P.

Vice-Presidents:

COLONEL THE HONOURABLE W. R. COLLINS, D.T.D., D.S.O., M.P.

HANS MERENSKY, DR.ING.H.C., D.SC.

H. J. VAN DER BIJL, PH. D., D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.

P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.

C. E. LEGAT, C.B.E., B.SC.

J. HUNT HOLLEY.

T. M. MACKENZIE.

OFFICERS:

Chairman: A. J. O'CONNOR, DIP.FOR.

Vice-Chairman: F. E. B. STRUBEN.

Hon. Editor: J. M. TURNBULL, M.M., DIP.FOR.

Hon. Secretary-Treasurer: P. E. DU PREEZ, B.A., B.SC.

Executive Committee:

A. J. O'CONNOR, DIP.FOR. (*Chairman*).

F. E. B. STRUBEN (*Vice-Chairman*).

I. J. CRAIB, M.F., PH.D.

H. A. LORENTZ, LL.D.

W. E. WATT, A.F.C., B.A., DIP.FOR.

J.M. TURNBULL, M.M., DIP.FOR. (*Hon. Editor*).

P. E. DU PREEZ, B.A., B.SC. (*Hon. Sec.-Treas.*).

ANNUAL REPORT FOR THE YEAR ENDED MAY 31ST, 1942.

Satisfactory progress was made by the Association during the past year.

The membership of the Association and permanent subscribers to its Journal at the close of the year were as follows:—

Life Members	7	
Full Members	170	
Associate Members	173	
Affiliated Members 91 with	99	nominees
Honorary Members	9	
Subscribers	25	
Total	483	

Fifty-three new members were enrolled by the Association and 30 memberships were terminated by death, resignation or cancellation, resulting in a nett increase of 23 members.

Under existing circumstances this increase must be regarded as satisfactory.

The accounts submitted with this report show that the income for the year was £564 16s. 8d. and the expenditure £544 6s. 0d., leaving an excess of income over expenditure of £20 10s. 8d. This figure compares favourably with a similar balance of £23 5s. 6d. for 1938/39, £10 18s. 4d. for 1939/40 and £97 19s. 9d. for 1940/41. If to this total is added the amount of £115 received in the form of donations during 1939/40, it will be seen that the Association has a balance of £267 14s. 3d. in hand. Of this amount £200 has been invested with the South African Permanent Mutual Building and Investment Society on fixed deposit for one year.

Two numbers of the Journal were published during the year and continued to receive favourable notices both in this country and overseas. The sizes of both these issues were normal despite the numbers of potential contributors to the Journal who are now on active military service.

The Association gratefully recognises its indebtedness to the Executive Committee for managing its affairs during the past year; also to the Editorial Committee for turning out two good numbers of the Journal; to the Hon. Editor, Mr. J. M. Turnbull, who is chiefly responsible for the high standard maintained by the Journal, and to the Hon. Secretary-Treasurer, Mr. P. J. A. Loseby, and later on Ir. D. R. de Wet, who had to render the usual amount of voluntary work. We again wish to thank all those who have sent contributions to the Journal.

The services of Mr. A. N. White who previously audited the Association's Books and Accounts could not be obtained, but Mr. G. M. du Preez, of the Division of Forestry Accounts Section, kindly consented to act as Honorary Auditor and his services are gratefully acknowledged.

(Sgd.) J. D. KEET,
Chairman.
28th August, 1942.

MINUTES OF THE FOURTH ANNUAL GENERAL MEETING

HELD AT SOMERSET HOUSE, VERMEULEN STREET, PRETORIA, AT 8 P.M. ON AUGUST 28TH, 1942.

1. Attendance: One visitor and 12 members were present. Mr. J. D. Keet was in the Chair.

2. The Hon. Secretary-Treasurer read the notice convening the meeting.

3. The Chairman after declaring the meeting open conveyed the apologies of Dr. H. A. Lorentz for his inability to attend and welcomed those present. He then referred to the death of the Vice-Chairman, Mr. H. A. Read, and regretted the loss the Association has sustained thereby. Mr. Read's enthusiasm for the objects of the Association, his concern for the welfare of the Association and his many practical suggestions to promote its interest would be difficult to surpass. The Chairman also referred to the death on Active Service of Mr. D. C. Prior, a foundation member of the Association, and felt sure that all members of the Association would join him in expressing his sincere sympathy to the relatives of both Mr. Read and Mr. Prior in their loss. He also hoped that all other members of the Association on Active Service were well and wished them all a safe return and happy re-union with their families and friends.

The Chairman stated that at a later stage of the proceedings of the evening he would have to announce his relinquishment of the Chairmanship of the Association. He however wished to thank the Association for its active support to him as Chairman. He often felt that, especially during the last two years, he had not done sufficient for the Association, but circumstances of which we are all aware did not permit of his giving the Association any more of his time. He especially wished to thank the office-bearers who were associated with him during the four years the Association has existed, as also the several committees, the Honorary Editor and the successive Honorary Secretary-Treasurers for their support and all the work they had so willingly and ably undertaken on behalf of the Association.

The Chairman then referred to the effect of War Conditions on forestry and on the timber industry. The local production of sawn softwood timber derived from State and private plantations and produced by State- and privately-owned sawmills during the last financial year amounted to nearly one-fourth of our pre-war importations. Notwithstanding the difficulties and delays attendant on importation of sawmilling machinery and equipment, new sawmills were gradually being erected and it could confidently be anticipated that local production during the current financial year would reach a considerable higher output provided labour and transportation problems did not prove to be insuperable. Prices of local softwood timbers had risen further in sympathy with prices of the imported, but were still well below the latter.

A notable feature of the expansion in sawmilling was the attention given by our machine-tool industry to the manufacture of sawmilling machinery and the success already achieved in that direction. It could be expected that a residue of this enterprise would be left to us on the return to normal conditions.

It was encouraging that thus far the inroad made into final crops has been negligible; the great bulk of the yield is still being obtained from intermediate yields. Forest owners would however, he felt sure, be prepared to sacrifice their future crops to any reasonable extent demanded by the exigencies of the present time.

At the last annual meeting the need for ensuring that locally produced timbers were placed on the market in a well-sawn and seasoned condition was stressed. Complaints were still being received that all was not well in this connection, however, but many users, and amongst them some of the most conservative and critical, had given testimony to the quality of the local product. This went to prove, as had been contended, that quality was merely a question of knowledge and care in sawing and seasoning. As this fact was now realised, greater attention was being given to the erection of seasoning kilns of the more modern types.

When defects due to sawing and seasoning had been remedied, further improvement could be secured through the grading of our mill products. The Forest Department would have to give a lead in this, as the sawmilling industry was not yet sufficiently organised to tackle this matter by itself. Provision for this had been made in the new Forest and Veld Conservation Act, and sufficient sawn timber and manufactured products were now turned out to permit of a system of grading being devised and applied, tentatively at first, as was done in the case of some of the more recently introduced grading rules in Canada.

Present conditions had also stimulated the use of hardwoods. The wagon-building industry was being slowly resurrected to supplement motor transport, now reduced through the restrictions on the use of motor fuel and tyres. In hardwood resources the country was in " short supply." The State particularly, but also the larger private owners, should consider the desirability of growing hardwoods to large dimensions and to ripe maturity. All trees should not necessarily be regarded as gold mines. For second and lower quality hardwood crops there was still good demand for material of pole sizes and interest had also been awakened in the possible use of this class of material for insulating- and hard-board. In fact if it were not for the difficulty at the present time of obtaining plant and machinery, developments in this direction would already have followed on a considerable scale.

Through the loss of our hardwood supplies in the Far East and owing to the difficulty of securing sufficient supplies of timber from the Americas, increasing attention was being given to the resources offered by tropical African forests of our neighbouring territories. Many good timbers obtained from these forests had been a great acquisition for our plywood and furniture industries, and it could confidently be expected that several of them would stay with us for good.

A limitation to this fuller and more general use was the want of a stabilised nomenclature, and authoritative description of their physical and other properties and a classification of the timbers according to their tried and known uses.

Present conditions had created wider interest in the possibilities of afforestation and should be an added incentive to those who are far-seeing and who can afford the outlay to invest some savings in the establishment of plantations. Mr. Keet was glad that the most recent number of the Journal contained some good practical advice on afforestation as an investment and also that that number contained an excellent article on the seasoning of South African timbers. Both these articles were appropriate to the times we were living in; the latter especially in view of the waste resulting from imperfect methods of seasoning and because of the great need for anti-waste measures in the use of timber.

With regard to other objects which our Association had at heart, he mentioned that the baobab tree had been proclaimed a protected tree, as also several species of fodder trees in the N.W. districts of the Cape Province and in certain districts of the Transvaal and Orange Free State. He also drew attention to the fact that a large area in the catchment of the Lake Arthur Dam, where soil erosion had extended to an alarming degree, had been proclaimed a conservation area under the Forest and Veld Conservation Act, in order to permit of the land being reclaimed under the provisions of that Act.

During the drought of last summer, in the Northern Transvaal, farmers and natives had unfortunately resorted to intensive draining on a large scale of vleis which formed the sponge of the water supplies, and to eradication of the few remnants of indigenous forests in the kloofs and streams, for the cultivation of crops. This would cause incalculable harm to the preservation of soil and water. This was a matter which had not escaped the attention of the Government, but it was to be hoped that the owners of the land could be persuaded to desist from these dangerous practices, before the Government has to apply the powers of the Law.

As this was his last address from the Chair, Mr. Keet, in conclusion, wished the Association a long, successful and useful life. We had not heralded the founding of this Association with a flourish of trumpets, unsettled conditions almost from our beginning had handicapped our growth, but much good work had been done quietly in the true ways of the forester and conservationist; it was quite inconceivable to him that this Association could ever come to grief through want of support. It definitely filled a place in the life of our nation that could not be taken by any other organisation.

4. The minutes of the Third Annual General Meeting of the Association, having been published in the seventh issue of the Journal, were taken as read. The minutes were confirmed and approved.

5. Arising out of the minutes the Chairman, in his reply to a question raised by Dr. Craib, reported that the idea of publishing a cigarette album of trees and shrubs had not been abandoned. Mr. Voorendyk had started a list of species which were considered suitable and some material had already been collected but to complete this would take a long time. He also informed the meeting that the question of Regional Committees had been discussed with several Conservators, but that nothing definite had resulted in view of current circumstances.

Attention was drawn to Mr. Bruins-Lich's remarks that more attention should be paid in the Journal to the propagation of indigenous tree species which will be of great interest, especially to municipalities for ornamental tree planting purposes. Mr. O'Connor suggested that in order to increase our membership the S.A. Lumber and Box Shook Manufacturers' Association should be contacted to find out who are not yet members of this Association. Farmers' associations could also be approached and in doing so stress should be laid on our efforts in regard to soil conservation. More articles on this subject, e.g., the activities of the Native Trust, should be published in the Journal. Dr. Craib drew attention to the conspicuous lack of articles in the Journal on the Sawmilling Industry—a subject which under present conditions ought to receive considerably more attenion.

6. The Hon. Secretary-Treasurer then read the Annual Report of the Executive Committee and presented the Financial Statement. On a motion by Mr. O'Connor, seconded by Mr. du Preez, these were adopted.

Dr. Craib drew attention to the indifferent Press comments on the Journal and suggested that this might be due to the fact that the Journal was invariably published at a date considerably later than that indicated on the title page.

The April, 1942, issue, for instance, appeared only in July and the Press might thereby have gained the impression that the contents were no longer of topical interest. The Chairman suggested that the Editorial Committee should go into this question with a view either to speeding up the publication of the Journal or to find some other solution.

7. The Chairman announced the result of the ballot for the election of new officers of the Association as follows:—

Chairman of the Association: Mr. A. J. O'Connor.

Member of the Executive Committee: Mr. W. E. Watt.

The Chairman thereupon invited Mr. O'Connor to take the Chair. The incoming Chairman then thanked the members of the Association for the honour they had bestowed upon him. He considered it a great honour to be the second Chairman of the S.A. Forestry Association and asked no further reward for any services which he might have rendered to forestry in South Africa. With the support and help of the members of the Association he would, however, endeavour to hand over the affairs of the Association to his successor in the same flourishing condition in which he had received them.

The Association was deeply indebted to Mr. Keet for his services in the past and in order to record this the Chairman moved an unopposed motion of thanks to Mr. Keet. Mr. O'Connor expressed the hope that Mr. Keet would remain in Pretoria for a very long time so that the Association might continue to benefit from his valuable experience.

8. The Chairman then announced that the ballot in connection with the proposed amendment to Section 4, Article VII of the Constitution was carried unanimously. Mr. Keet, seconded by Dr. Craib, moved that the amendment be published in the next issue of the Journal.

The amendment entailed deletion of the entire section and substitution of the following in its place:

"The Executive Committee shall appoint members of the Association to form an Editorial Committee, which shall comprise the Editor and such Associate Editors as may be considered necessary. Each Associate Editor shall hold office from date of appointment until the close of the financial year."

9. Mr. Watt asked that it be explained to the meeting why the post of Vice-Chairman was not to be filled by ballot. Mr. Read was elected Vice-Chairman for a period of three years and his term of office only expired on 31st May, 1944. In terms of Section 3, Article V of the Constitution, the Executive Committee had the power to fill any vacancies due to death or resignation for the unexpired portion of the period during which the officer replaced would normally have served. The Chairman informed the meeting that the Executive Committee at its last meeting decided to offer the Vice-Chairmanship to Dr. H. A. Lorentz, a member of the Executive Committee, but he had written to say that although he was willing to serve, he would, on account of present difficulties attendant on travelling, prefer to see a younger member and one residing nearer Pretoria take the post. The Committee thereupon offered the post to Mr. Connell Maggs, who was unfortunately not able to accept it as he had not been released from Active Military Service. The vacancy has therefore not yet been filled.

10. Mr. Webster, representative of the Town Council of Krugersdorp, remarked on the difficulty his Council had in obtaining small quantities of nursery trays or tins. He was however hoping that they would soon be in a position to cut shooks for the purpose out of *P. patula* and *P. insignis* grown locally. Up to the present wood from their plantations had been sold exclusively as mining timber. He expressed his pleasure in having had the opportunity to attend the meeting.

11. Ir. H. L. Malherbe, seconded by Mr. P. E. du Preez, moved a motion of thanks to the Executive Committee for their services during the past year. An unopposed motion was adopted and thanks expressed to the Maggs Investment Co. for placing their Council Room at the disposal of the Association.

12. The meeting terminated at 10.15 p.m.

(Sgd.) D. R. DE WET,

Hon. Secretary-Treasurer.

28th August, 1942.

SOUTH AFRICAN

INCOME AND EXPENDITURE ACCOUNT

EXPENDITURE

To Publication of Journal No. 6	£190 9 9		
No. 7	178 9 9		
	£368 19 6		
Add amount outstanding No. 8	239 7 6		
No. 7	8 2 8		
	£616 9 8		
Less amount due for No. 6 (1940-41)	190 9 9	£425	19 11
To Reprints Nos. 6 and 7	£54 7 5		
Add amount outstanding for No. 7	12 0 0	66	7 5
To Stationery and Office Sundries		14	9 0
To Postage and Stamps		14	12 6
To Miscellaneous		5	16 0
To Bank Commission		7	6 11
To Bank Charges		2	2 9
To Bad Debts —			
(a) Sale of Journals	£1 10 0		
(b) Subscriptions, resigned and expelled members	6 1 6	7	11 6
To Balance (Income over Expenditure)		20	10 8
		£564	16 8

BALANCE SHEET AS

LIABILITIES

Subscriptions Paid in Advance—			
6 Life Members	£70 7 0		
1 new Life Member	14 14 0		
Other Members as per Cash Book (1942/43/44)	14 6 11		
1 Associate Member (1942/48)	2 5 0	£101	12 11
Journals Paid in Advance		2	4 0
Sundry Creditors Journal No. 8	£239 7 6		
(Part) No. 7	8 2 8		
Reprints No. 7	12 0 0	259	10 2
Capital Account—			
Accumulated Surplus 1938/41	£247 3 7		
Surplus for 1941/42	20 10 8	267	14 3
		£631	1 4

I hereby certify that I have examined the books and accounts of the Account and Balance Sheet correctly reflect the Society's position.

FORESTRY ASSOCIATION

FOR THE YEAR ENDED 31ST MAY, 1942

INCOME

By	Subscriptions—			
	6 Life Members		£6 6 0	
	Other Members as per Cash Book		346 5 6	
By	Sale of Journals as per Cash Book		115 0 7	
By	Sale of Reprints as per Cash Book		69 3 3	
By	Advertisement as per Cash Book		24 16 2	
By	Commission as per Cash Book		3 5 2	
				£564 16 8

AT 31ST MAY, 1942

ASSETS

To	Cash in Bank	£317 13 2		
To	Cash Invested in Building Society	200 0 0		
To	Cash in Hand	3 3 0		£520 16 2
To	Sundry Debtors Journals	£44 1 9		
	Reprints	38 17 9		
	Advertisements	11 10 8		94 10 2
To	Subscriptions in Arrear			15 15 0
				£631 1 4

South African Forestry Association and that the above Income and Expenditure

(Sgd.) G. M. DU PREEZ.

SUID-AFRIKAANSE BOSBOUVERENIGING

Beskermheer:

SY EKSELLENSIE DIE GOEWERNEUR-GENERAAL,
DIE HOOGEDELAGBARE SIR PATRICK DUNCAN,
G.C.M.G., K.C.

President:

DIE EDELAGBARE KOLONEL DENEYS REITZ, L.V.

Vise-Presidents:

DIE EDELAGBARE KOLONEL W. R. COLLINS, D.T.D., D.S.O., L.V.

HANS MERENSKY, DR.ING.H.C., D.SC.

H. J. VAN DER BIJL, PH. D., D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.

P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.

C. E. LEGAT, C.B.E., B.SC.

J. HUNT HOLLEY.

T. M. MACKENZIE.

AMPSDRAERS:

Voorsitter: A. J. O'CONNOR, DIP.FOR.

Vise-Voorsitter: F. E. B. STRUBEN.

Ere Redakteur: J. M. TURNBULL, M.M., DIP.FOR.

Ere Sekretaris-Tesourier: P. E. DU PREEZ, B.A., B.SC.

Uitvoerende Komitee:

A. J. O'CONNOR, DIP.FOR. (*Voorsitter*).

F. E. B. STRUBEN (*Vise-Voorsitter*).

I. J. CRAIB, M.F., PH.D.

H. A. LORENTZ, LL.D.

W. E. WATT, A.F.C., B.A., DIP.FOR.

J. M. TURNBULL, M.M., DIP.FOR. (*Ere Redakteur*).

P. E. DU PREEZ, B.A., B.SC. (*Ere Sek.-Tes.*).

JAARVERSLAG VIR DIE JAAR GEËINDIG 31 MEI 1942.

Die Vereniging het gedurende die afgelope jaar bevredigende vooruitgang gemaak.
Die ledetal van die Vereniging en intekenaars op die Tydskrif was aan die end van die jaar as volg:—

Lewenslange lede	7	
Volle lede	170	
Geassosieerde lede	173	
Geaffilieerde lede, 91, met	99	verteenwoordigers
Ere lede	9	
Intekenaars	25	
Totaal	483	

Drie-en-vyftig nuwe lede is deur die Vereniging ingeskryf en die lidmaatskap van dertig persone is deur afsterwe, bedanking of skorsing beëindig, met die gevolg dat die vermeerdering 23 lede stel.

Onder heersende omstandighede moet hierdie toename as gunstig beskou word.

Uit die rekeninge wat saam met hierdie verslag voorgelê word, blyk dat die inkomste vir die jaar £564 16s. 8d. en die uitgawes £544 6s. 0d. bedra het, sodat daar 'n batige saldo van £20 10s. 8d. is. Hierdie syfer kan gunstig vergelyk word met dergelyke saldos van £23 5s. 6d. vir 1938/39, £10 18s. 4d. vir 1939/40 en £97 19s. 9d. vir 1940/41. Indien die bedrag van £115, wat gedurende 1939/40 in die vorm van skenkings ontvang is, hierby getel word, sal opgemerk word dat die Vereniging 'n batige saldo van £267 14s. 3d. in die kas het. Hiervan is £200 by die ,,South African Permanent Mutual Building and Investment Society'' vir een jaar as 'n vaste deposito belê.

Twee uitgawes van die Tydskrif is gedurende die jaar gepubliseer en het weer gunstige resensies sowel oorsee as hier te lande uitgelok. Die groottes van altwee uitgawes was normaal, ten spyte daarvan dat 'n groot aantal potensiële medewerkers aan die Tydskrif nou op aktiewe militêre diens is.

Die Vereniging wil graag sy dank uitspreek teenoor die Uitvoerende Komitee vir die wyse waarop laasgenoemde die sake van die Vereniging gedurende die afgelope jaar behartig het; teenoor die Redaksie Komitee vir die twee uitgawes van die Tydskrif; teenoor die Ere-Redakteur, mnr. J. M. Turnbull, wat hoofsaaklik verantwoordelik is vir die hoë standaard wat in die Tydskrif gehandhaaf is, en teenoor die Ere-Sekretaris-Tesourier, mnr. P. J. A. Loseby, en later ir. D. R. de Wet, wat die gebruiklike roetinewerk vrywillig gedoen het. Ten slotte wil ons nog almal wat bydraes vir die Tydskrif ingestuur het, weereens daarvoor bedank.

Die dienste van mnr. A. N. White wat voorheen die Vereniging se boeke en rekeninge geouditeer het, was nie meer beskikbaar nie, maar mnr. G. M. du Preez van die Afdeling Bosbou se rekeninge-seksie het goedgunstiglik ingestem om as Ere-Ouditeur op te tree. Sy dienste word met dank erken.

(Get.) J. D. KEET,
Voorsitter.
28 Augustus 1942.

NOTULE VAN DIE VIERDE ALGEMENE JAARVERGADERING

GEHOU OP 28 AUGUSTUS 1942, OM 8 UUR N.M. TE SOMERSET HOUSE, VERMEULENSTRAAT, PRETORIA.

1. Opkoms: Een besoekster en 12 lede was aanwesig. Mnr. J. D. Keet het as Voorsitter opgetree.

2. Die Ere-Sekretaris-tesourier het die kennisgewing wat die vergadering byeenroep, voorgelees.

3. Nadat die Voorsitter die vergadering geopen verklaar het, het hy 'n verontskuldiging van dr. H. A. Lorentz oorgedra wat nie aanwesig kon wees nie, en al die aanwesiges verwelkom. Hy het toe na die dood van die Onder-voorsitter, mnr. H. A. Read, verwys en die verlies dat die Vereniging daardeur gely het, betreur. Die geesdrif van mnr. Read vir die doel en strewe van die Vereniging, sy ywer vir die welslae daarvan, en die menigvuldige praktiese voorstelle wat hy aan die hand gedoen het om die Vereniging se belange te bevorder, sal nie

maklik oortref kan word nie. Die Voorsitter het ook na die dood op aktiewe diens van mnr. D. C. Prior, een van die eerste lede van die Vereniging, verwys. Hy is seker dat hy namens al die lede van die Vereniging praat wanneer hy sy innige meegevoel met die familielede van beide mnre. Read en Prior in hul verlies uitspreek. Hy hoop ook dat al die ander lede van die Vereniging wat op aktiewe diens is gesond is, en wens hulle 'n veilige terugkeer en gelukkige hereniging met hulle families en vriende toe.

Die Voorsitter het daarna meegedeel dat hy tydens die verrigtings later in die aand sal moet aankondig dat hy die Voorsitterskap van die Vereniging gaan neerlê. Hy wens egter om die Vereniging vir die ondersteuning wat hy as Voorsitter geniet het, te bedank. Hy het dikwels, veral gedurende die afgelope twee jaar, gevoel dat hy nie voldoende aandag aan die Vereniging geskenk het nie, maar omstandighede wat aan ons almal bekend is, het nie toegelaat dat hy meer van sy tyd in belang van die Vereniging kon opoffer nie. Hy wens veral om die ampsdraers wat die Vereniging gedurende die afgelope vier jaar saam met hom gedien het, te bedank, asook die verskillende komitees, die Eredakteur en die agtereenvolgende ere-sekretaris-tesouriers vir hul ondersteuning en vir al die werk wat hulle so gewilliglik en op so'n bekwame wyse in belang van die Vereniging onderneem en verrig het.

Die Voorsitter het daarop na die uitwerking van die oorlogstoestande op bosbou en veral op die houtnywerheid verwys. Die plaaslike produksie van gesaagde timmerhout uit Staats- en private plantasies afkomstig en wat gedurende die afgelope boekjaar deur Staats- en private saagmeules verwerk is, het byna eenvierde van die hoeveelheid wat voor die oorlog ingevoer is, bedra. Nieteenstande die moeilikhede en vertragings in verband met die invoer van saagmeulmasjinerie en -uitrusting, is nuwe saagmeules tog langsamerhand opgerig en daar kan met sekerheid verwag word dat plaaslike produksie gedurende die lopende boekjaar aanmerklik hoër sal wees mits arbeids- en vervoerprobleme nie onoorkomelik blyk te wees nie. Die pryse van plaaslike geproduseerde timmerhout het nog verder in ooreenstemming met die pryse van ingevoerde hout gestyg, maar dit is tog nog heelwat laer as laasgenoemde.

Opvallend in verband met die uitbreiding van die saagmeulnywerheid was die aandag wat ons masjineriegereedskapsnywerheid aan die vervaardiging van saagmeulmasjinerie bestee het en die sukses wat alreeds ten opsigte daarvan bereik is. Daar sou verwag kon word dat 'n gedeelte van hierdie nywerheid by die terugkeer tot normale omstandighede sal bly voortbestaan.

Dit is bemoedigend om op te merk dat die eindopbrengs tot dusver feitlik onaangetas is; die grootste gedeelte van die opbrengs word nog steeds van tussenopbrengste verkry. Hy voel egter oortuig daarvan dat boseienaars bereid sal wees om hul toekomstige eindopbrengste in redelike mate op te offer indien teenswoordige omstandighede dit vereis.

Met die vorige jaarvergadering is die noodsaaklikheid om toe te sien dat plaaslik geproduseerde timmerhout in 'n behoorlik gesaagde en gedroogde toestand op die mark gebring word, beklemtoon. Klagtes word egter nog steeds ontvang dat alles in verband hiermee nie pluis is nie, maar baie verbruikers, waaronder sommige van die mees konserwatiewe en kritiese, het reeds die kwaliteit van die plaaslike produk geloof. Dit het daartoe bygedra om te bewys, soos voorheen reeds beweer is, dat kwaliteit maar slegs 'n kwessie van kennis en sorg is ten opsigte van saag en droging. Daar hierdie feit nou besef word, word ook meer aandag bestee aan die oprigting van die meer moderne tipe droogoonde.

Sodra die gebreke as gevolg van saag en droging uit die weg geruim is, kan verdere verbetering verkry word deur ons saagmeulprodukte ook nog te gradeer. Die Departement van Bosbou sal hiermee die voortou moet neem omdat die saagmeulnywerheid nog nie voldoende georganiseer is om hierdie saak self aan te pak nie. Voorsiening is hiervoor in die nuwe Bos- en Veldbewaringswet gemaak en genoeg gesaagde timmerhout en ander vervaardigde produkte word opgelewer om die ontwerp en toepassing van 'n graderingstelsel moontlik te maak; eers by wyse van proef natuurlik soos in die geval van sommige van die jongste graderingsregulasies wat in Kanada ingevoer is.

Teenswoordige omstandighede het ook die gebruik van loofhout aangewakker. Die wanywerheid herleef weer langsamerhand om motorvervoer wat nou as gevolg van die beperkings wat op die gebruik van motorbrandstof en -bande gelê is, aan te vul. Wat loofhoutvoorrade betref, bestaan daar in die land 'n tekort. Die Staat veral, maar ook die groter private grondeienaars behoort die wenslikheid te oorweeg om loofhoutsoorte tot groter afmetings en rypheid te laat groei. Alle bome hoef nie noodsaaklikerwys as goudmyne beskou te word nie. Vir

loofhouttoeste van tweede en laer gehalte was daar nog 'n groot aanvraag ten opsigte van materiaal van paalgrootte, en belangstelling is ook gewek in die moontlike gebruik van hierdie klas materiaal vir insuleer- en pulpbord. Feit is, dat as dit nie op die oomblik so moeilik was om masjinerie en die nodige installasie te kry nie, ontwikkeling in hierdie rigting reeds op aansienlike skaal sou gevorder het.

As gevolg van die verlies van ons loofhoutbronne in die Verre Ooste en weens die moeilikheid om voldoende voorraade timmerhout uit die Amerikas te bekom, word al hoe meer aandag bestee aan die voorrade wat beskikbaar is in die Afrikaanse tropiese bosse van ons aangrensende gebiede. Verskeie houtsoorte uit hierdie bosse afkomstig is 'n groot aanwins vir ons laaghout- en meubelnywerhede en dit kan met sekerheid verwag word dat verskeie van hulle 'n blywende mark hier gevind het. Die algemene gebruik van hierdie houtsoorte was in sekere mate beperk deur die gebrek aan gestabiliseerde benamings, gesaghebbende beskrywings van hul fisiese en ander einskappe en 'n klassifikasie volgens hul getoetste en bekende gebruike.

Teenswoordige omstandighede het meer algemene belangstelling in die moontlikhede van bebossing opgewek en behoort 'n dryfveer te wees vir diegene wat vérsiende is en wat dit kan bekostig om 'n gedeelte van hulle besparings in die aanleg van plantasies te belê. Mnr. Keet het sy blydskap uitgespreek daaroor dat die jongste uitgawe van die Tydskrif goeie en nuttige advies oor bebossing, as 'n belegging, bevat het; ook dat dieselfde uitgawe 'n uitmuntende bydrae oor die droging van Suid-Afrikaanse timmerhout bevat. Altwee hierdie bydraes was toepaslik op die tye waarin ons tans leef; laasgenoemde veral, met die oog op die afval weens slegte drogingsmetodes en die groot noodsaaklikheid vir maatreëls teen vermorsing by die gebruik van timmerhout.

Ten opsigte van ander sake wat ons Vereniging na aan die hart lê, het hy daarvan melding gemaak dat die kremetartboom nou tot beskermde boom geproklameer is, asook verskeie boomsoorte wat as voerplante in die Noordwestelike distrikte van die Kaap-provinsie en in sekere distrikte van Transvaal en Oranje Vrystaat groei. Hy het ook die aandag gevestig op die feit dat 'n groot oppervlakte in die opvanggebied van die Arthur-dam, waar gronderosie tot 'n verontrustende mate uitgebrei het, kragtens die Bos- en Veldbewaringswet tot konservasiegebied geproklameer is sodat die grond kragtens die bepalings van daardie Wet weer herwin kan word.

Gedurende die droogte van verlede somer het boere en naturelle in Noord-Transvaal ongelukkig hul toevlug geneem tot die dreinering op groot skaal van vleie wat as spons vir die watervoorrade gedien het en tot die uitroeiing van die paar oorblyfsels van inheemse bosse in die klowe en langs strome, ten einde gewasse daar te kweek. Dit sal onberekenbare skade aan die bewaring van grond en water verrig. Dit is 'n saak wat die Regering se aandag nie ontduik het nie, maar ons moet vertrou dat grondeienaars beweeg sal kan word om van hierdie gevaarlike gewoontes af te sien voordat die Regering dit nodig ag om sy magte kragtens die Wet toe te pas.

Aangesien dit sy laaste toespraak as Voorsitter was, het mnr. Keet die Vereniging ten slotte 'n lang, suksesvolle en nuttige bestaan toegewens. Ons het nie die stigting van hierdie Vereniging met trompetgeskal aangekondig nie en onsekere omstandighede het byna van die begin af ons groei gestrem, maar baie goeie werk is stil en in die regte gees van die bosbouer en bewaarder verrig; dit is heeltemal ondenkbaar vir hom dat hierdie Vereniging ooit as gevolg van gebrek aan ondersteuning ten gronde sal gaan. Dit vul beslis 'n plek in die lewe van ons nasie wat nie deur enige ander organisasie ingeneem kan word nie.

4. Aangesien die Notule van die Derde Algement Jaarvergadering van die Vereniging in die sewende uitgawe van die Tydskrif gepubliseer is, is dit as gelees aangeneem. Die notule is bekragtig en goedgekeur.

5. Na aanleiding van die notule het die Voorsitter, in antwoord op 'n vraag van dr. Craib, meegedeel dat die plan om 'n sigaretalbum van bome en struike te publiseer nog nie prysgegee is nie. Mnr. Voorendyk het 'n lys van soorte wat vir die doel geskik geag word, opgestel en 'n begin is gemaak met die versameling van materiaal. Dit sal egter nog geruime tyd duur.

Hy het ook die vergadering ingelig dat hy die wenslikheid van Streek-komitees met verskeie Bosbewaarders bespreek het, maar dat, met die oog op heersende omstandighede, niks definitiefs besluit is nie.

Daar is op mnr. Bruins-Lich se opmerkings gewys dat in die Tydskrif meer aandag geskenk moet word aan die kweek van inheemse boomsoorte, wat vir sierdoeleindes en veral vir munisipaliteite van groot belang sal wees. Mnr. O'Connor het aan die hand gedoen dat met die S.A. Lumber and Box Shook Manufacturers'

Association in verbinding getree moet word om uit te vind wie van hulle nog nie lid van ons Vereniging is nie. Boereverenigings kan ook genader word en in hierdie geval moet nadruk gelê word op ons pogings in verband met grondbewaring. Meer artikels oor hierdie onderwerp, byvoorbeeld oor die werksaamhede van die Naturelletrust, behoort in die Tydskrif gepubliseer te word. Dr. Craib het ook die aandag gevestig op die gebrek aan artikels in die Tydskrif oor die saagmeulnywerheid — 'n onderwerp wat onder teenswoordige omstandighede veel meer aandag behoort te geniet.

6. Die Ere-Sekretaris-tesourier het vervolgens die jaarverslag van die Uitvoerende Komittee gelees en die balansstaat voorgelê. Op voorstel van mnr. O'Connor, gesekondeer deur mnr. du Preez, is hierdie stukke aangeneem.

Dr. Craib het op die belangelose perskommentaar op die Tydskrif gewys en meen dat dit miskien te wyte is aan die feit dat die Tydskrif byna sonder uitsondering heelwat later gepubliseer word as wat die titelblad vermeld word. Die uitgawe van April 1942, het byvoorbeeld eers in Julie verskyn en die pers mag daardeur onder die ondruk gebring word dat die inhoud nie meer van aktuele belang is nie. Die Voorsitter het aan die hand gegee dat die Redaksiekomitee op hierdie saak moet ingaan ten einde die publikasie van die Tydskrif te bespoedig of om 'n ander oplossing daarvoor te vind.

7. Die Voorsitter het die uitslag van die verkiesing van ampsdraers van die Vereniging as volg bekend gemaak:—

Voorsitter van die Vereniging: Mnr. A. J. O'Connor.

Lid van die Uitvoerende Komitee: Mnr. W. E. Watt.

Hy het mnr. O'Connor toe gevra om sy plek in die voorsitterstoel in te neem. Die intredende Voorsitter het vervolgens die lede van die Vereniging bedank vir die eer wat hulle hom bewys het. Hy beskou dit 'n groot eer om die tweede Voorsitter van die Suid-Afrikaanse Bosbouvereniging te wees en vra geen verdere beloning vir enige dienste wat hy in die belang van bosbou in Suid-Afrika mag gelewer het nie. Met die ondersteuning en hulp van die lede van die Vereniging sal hy egter trag om die Vereniging se sake aan sy opvolger in dieselfde vooruitstrewende toestand te oorhandig as wat hy dit ontvang het. Die Vereniging is aan mnr. Keet innige dank verskuldig vir sy dienste in die verlede en om dit te boekstaaf het die Voorsitter 'n onbestrede mosie van dank aan mnr. Keet voorgestel. Mnr. O'Connor het die hoop uitgespreek dat mnr. Keet nog vir 'n baie lang tyd in Pretoria sal bly sodat die Vereniging ook nog in die toekoms voordeel uit sy waardevolle ondervinding sal kan trek.

8. Die Voorsitter het aangekondig dat die stemming in verband met die voorgestelde wysiging van subartikel 4 van artikel VII van die Grondwet eenparig ten gunste daarvan was. Mnr. Keet het voorgestel, gesekondeer deur dr. Craib, dat die wysiging in die volgende uitgawe van die Tydskrif gepubliseer word.

Die wysiging het meegebring dat die hele subartikel geskrap en deur die volgende vervang moes word:

„Die Uitvoerende Komitee stel lede van die Vereniging aan om 'n Redaksiekomitee te vorm wat bestaan uit die Redakteur en sodanige Mede-redakteurs as wat nodig geag mag word. Elke Mede-redakteur beklee sy pos vanaf die datum van aanstelling tot die sluiting van die boekjaar."

9. Mnr. Watt het gevra dat aan die vergadering verduidelik moet word waarom die vakante Ondervoorsitterspos nie ook deur stemming gevul is nie. Mnr. Read is tot Ondervoorsitter gekies vir 'n tydperk van drie jaar en sy ampsperiode sou eers op 31 Mei 1944, verstryk het. Kragtens subartikel 3 van artikel V van die Grondwet is die Uitvoerende Komitee by magte om enige vakatures as gevolg van dood of bedankings vir die onverstreke tydperk wat so'n beampte normalerwys sou gedien het, te vul. Die Voorsitter het meegedeel dat die Uitvoerende Komitee by sy laaste vergadering besluit het om die Ondervoorsitterskap aan dr. H. A. Lorentz, 'n lid van die Uitvoerende Komitee, aan te bied, maar dat hy geantwoord het dat alhoewel hy gewillig was om te dien hy as gevolg van huidige moeilikhede in verband met vervoer sou verkies het dat 'n jonger lid en een wat nader aan Pretoria woon, die amp neem. Die Komitee het daarna die pos aan mnr. Connell Maggs aangebied, maar hy kon dit ongelukkig ook nie aanneem nie omdat hy nie van aktiewe militêre diens vrygestel is nie.

10. Mnr. Webster, die verteenwoordiger van die Stadsraad van Krugersdorp, het gewys op die moeilikheid wat sy Raad ondervind om klein hoeveelhede kwekerykissies of -blikke te verkry. Hy het egter gehoop dat hulle gou in staat sou wees om vir hierdie doel kisplankies uit plaaslik gekweekte *P. patula* en *P. insignis*

te saag. Tot dusver is al die hout uit hul plantasies uitsluitend as mynhout verkoop. Mnr. Webster was bly dat hy die geleentheid gehad het om die vergadering by te woon.

11. Ir. H. L. Malherbe het, gesekondeer deur mnr. P. E. du Preez, 'n mosie van dank aan die Uitvoerende Komitee vir hul dienste gedurende die afgelope jaar, voorgestel. 'n Onbestrede mosie van dank teenoor die Maggs Investment Co., wat goedgunstiglik hul Raadkamer tot beskikking van die Vereniging gestel het, is aangeneem.

12. Die vergadering het om 10.15 n.m. verdaag.

(Get.) D. R. DE WET,
Ere-Sekretaris-tesourier.
28 Augustus 1942.

SUID-AFRIKAANSE

REKENING VAN INKOMSTE EN UITGAWES

UITGAWES

Aan Publikasie van Tydskrif No. 6	£190 9 9		
No. 7	178 9 9		
	£368 19 6		
Plus uitstaande bedrag No. 8	239 7 6		
No. 7	8 2 8		
	£616 9 8		
Min bedrag uitstaande No. 6 (1940/41)	190 9 9		
Aan Herdukke—			
Plus uitstaande bedrag No. 6 en 7	£54 7 5		
No. 7	12 0 0	66	7 5
Aan Skryfbehoeftes en kantoorbenodighede		14	9 0
Aan Posgeld en seëls		14	12 6
Aan Bankkommissie		7	6 11
Aan Bankgelde		2	2 9
Aan Slegte skuld—			
(a) Verkoop van Tydskrif	£1 10 0		
(b) Ledegeld, bedankings en skorsings	6 1 6	7	11 6
Aan Diverse		5	16 0
Aan Saldo (Inkomste-uitgawes)		20	10 8
		£564	16 8

BALANSSTAAT OP

LASTE

Ledegeld: Vooruitbetalings—			
6 Lewenslange lede	£70 7 0		
1 Nuwe lewenslange lid	14 14 0		
Ander lede volgens kasboek (1942/43/44)	14 6 11		
1 Geassosiëerde lid (1942-48)	2 5 0	£101	12 11
Tydskrif: Vooruitbetalings		2	4 0
Diverse krediteure Tydskrif No. 8	£239 7 6		
No. 7	8 2 8		
(Herdrukke) No. 7	12 0 0	259	10 2
Kapitaalrekening—			
Opgehoopte oorskot 1938/41	£247 3 7		
1941/42	20 10 8	267	14 3
		£631	1 4

Ek sertifiseer hiermee dat ek die boeke en rekenings van die Suid- inkomste en uitgawes en balansstaat die Vereniging se finansiële sake juis weergee.

BOSBOUVERENIGING

VIR DIE JAAR GEËINDIG 31 MEI 1942

INKOMSTE

Per Ledegeld—				
6 Lewenslange Lede			£6	0 0
Ander Lede volgens kasboek			346	5 6
Per Verkoop van tydskrifte volgens kasboek			115	0 7
Per Verkoop van herdrukke volgens kasboek			69	3 3
Per Advertensies volgens kasboek			24	16 2
Per Kommissie volgens kasboek			3	5 2
			£564	16 8

31 MEI 1942

BATE

Aan Kontant in Bank	£317	13 2		
Aan Kontant in Bougenootskap	200	0 0		
Aan Kontant op hande belê	3	3 0	£520	16 2
Aan Diverse skuldenaars—				
Tydskrifte	£44	1 9		
Herdrukke	38	17 9		
Advertensies	11	10 8	94	10 2
Aan Agterstallige ledegeld			15	15 0
			£631	1 4

Afrikaanse Bosbouvereniging nagegaan het en dat bostaande rekening van

(Get.) G. M. DU PREEZ.

EDITORIAL COMMITTEE.

J. M. TURNBULL, M.M., DIP.FOR.—*Chairman.*

I. J. CRAIB, M.F. PH.D.

NILS B. ECKBO, M.F.

A. J. O'CONNOR, DIP.FOR. *(Ex officio).*

D. B. VAN SOELEN, B.A., LL.B.

Contributions on any aspects of forestry or allied subjects will be considered by the Editorial Committee, and should be addressed to the Editor, The Journal of the South African Forestry Association, P.O. Box 727, Pretoria. Articles in excess of 1,000 words should be accompanied by uncopyrighted summaries, not exceeding five per cent. of length of originals. Twelve reprints of each article will be furnished to its author, free. Reprints beyond that number may be obtained, if ordered before the end of the month preceding that of issue, at the following rates per unit of four text pages:—

100 copies	*£0 16 6*
250 ,,	*£1 5 6*
500 ,,	*£2 0 6*
1,000 ,,	*£3 10 6*

Incomplete units will be charged as for complete units. Printed covers ordered at same time as the text will be provided at 21/6 per 100, and 2/- for every 50 in excess thereof. Illustrations extra by arrangement.

Articles will be published in the language in which they are submitted. Summaries may be submitted in either or both official languages.

The Association does not hold itself responsible for statements or views expressed by authors.

Readers are urged to consider the Association's advertisers as occasion may arise.

REDAKSIE-KOMITEE.

J. M. TURNBULL, M.M., DIP.FOR.—*(Voorsitter.)*

I. J. CRAIB, M.F., PH.D.

NILS B. ECKBO, M.F.

A. J. O'CONNOR, DIP.FOR. *(Ex officio).*

D. B. VAN SOELEN, B.A., LL.B.

Artikels oor alle aspekte van bosbou sal deur die Redaksie-Komitee in oorweging geneem word, en moet aan die Redakteur, „Die Tydskrif van die Suid-Afrikaanse Bosbouvereniging," Posbus 727, Pretoria, gerig word. Artikels van meer as 1,000 woorde moet van 'n opsomming waarvan kopiereg nie voorbehou is nie, van nie meer as vyf persent van die lengte van die artikel self vergesel word. Twaalf herdrukke van elke artikel sal kosteloos aan die skrywer daarvan verskaf word. Mits hulle bestel word voor die einde van die maand voorafgaande dié van uitgawe, kan herdrukke bo hierdie hoeveelheid teen die volgende pryse vir eenhede van vier teksblaaie verkry word:—

100 kopieë	*£0 16 6*
250 „	*£1 5 6*
500 „	*£2 0 6*
1,000 „	*£3 10 6*

Onvolledige eenhede sal teen dieselfde prys as volledige eenhede gereken word. Gedrukte omslae, bestel belyktydig met die herdrukke, sal voorsien word ten 21/6 per 100, en 2/- per elke 50 bo die eerste 100. Illustrasies ekstra.

Kontribusies sal gepubliseer word in die taal waarin hulle ingestuur word. Opsommings mag in enige of beide amptelike tale ingedien word.

Die Vereniging neem geen verantwoordelikheid aan vir die bewerings of opinies van skrywers nie.

Lesers word versoek om die Vereniging se adverteerders waar gerieflik, in aanmerking te neem.

CONTENTS—INHOUD

The Association does not hold itself responsible for statements or views expressed by authors. With the exception of authors' summaries copyright of all articles is reserved.

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of menings wat deur skrywers uitgespreek mag word nie. Met uitsondering van skrywers se opsommings, word kopiereg van alle artikels voorbehou.

PAGE
BLADSY

EDITORIAL NOTES AND COMMENTS—VAN DIE REDAKSIE 1
OUR CHAIRMEN.
APPOINTMENT OF VICE-CHAIRMAN.
ORGANIZATION OF SAWMILLING INTERESTS.
IMPORTATION OF TIMBER.
INVOER VAN HOUT.
CAESAR'S BRIDGE.
DIVISION OF FORESTRY'S ANNUAL REPORT.
THE JOURNAL IN WAR TIME.

STATE AFFORESTATION AFTER THE WAR, *by I. J. Craib, M.F., Ph.D.* 5

A SEMI-EVERGREEN FORM OF LOMBARDY POPLAR, *by O. S. H. Reinecke, B.S.A., D.Sc.*, and *C. L. Wicht, B.Sc., B.A., Dr.Ing.* 19

A NOTE ON THE VEGETATIVE PROPAGATION OF *Pinus Insignis*, *by S. P. Sherry, B.Sc.* 23

A STUDY IN STEM DESIGN, *by John M. Turnbull, Dip.For.* 26

MODERN METHODS OF WOOD CHARCOAL MANUFACTURE, *by P. J. A. Loseby, B.A., B.Sc.*, and *C. C. van der Merwe, M.Sc.* 31

LUMBER MILLERS AND SHOOK MANUFACTURERS GET TOGETHER, *by Phil White* 44

PUBLICATIONS RECEIVED 47

FIFTEEN YEARS' MARKETING RESEARCH IN SOUTH AFRICAN TIMBERS, *by Nils B. Eckbo, M.F.* 48

DIE BEDREIGING VAN HOUTWURM-AANVAL IN BOUHOUT EN DIE VOORKOMING DAARVAN, *deur P. M. D. Krogh* 51

CORRESPONDENCE 55
THE VALUE OF AN IMMATURE PLANTATION.
CAESAR'S BRIDGE.

REVIEWS 59
REPORT ON THE DIVISION OF FORESTRY FOR THE YEAR ENDED 31ST MARCH, 1941.



A. J. O'CONNOR, Esq., Dip.For.

CHAIRMAN

THE SOUTH AFRICAN FORESTRY ASSOCIATION

THE JOURNAL OF THE
SOUTH AFRICAN FORESTRY ASSOCIATION
No. 9. OCTOBER, 1942.

DIE TYDSKRIF VAN DIE
SUID-AFRIKAANSE BOSBOUVERENIGING
No. 9. OKTOBER, 1942.

EDITORIAL NOTES AND COMMENTS
VAN DIE REDAKSIE

OUR CHAIRMEN.

Members will view with regret the relinquishment by Mr. Keet of the office of Chairman, which he has so ably held since the Association's inception. In view of his recent assumption of the onerous duties of Timber Controller in addition to his normal activities as Director of Forestry, two posts the exactions of which will fully absorb even his well-known capacity for industry and enthusiasm, his decision was inevitable. In his valedictory address to the Association delivered at its last Annual General Meeting, he expressed regret that during the previous two years he had not done more for it. All who have been directly concerned with the conduct of the Association's business, in reply to this disclaimer, can heartily assure Mr. Keet that any falling off in guidance, inspiration and actual hard work on his part that he may have felt conscious of has at no time been noticed by them.

The Association is to be congratulated on the appointment to the position relinquished by Mr. Keet of Mr. A. J. O'Connor, Assistant Director of Forestry, whose services to Forestry and Forest Botany in South Africa have been of a distinguished nature.

APPOINTMENT OF VICE-CHAIRMAN.

We at the same time welcome the appointment of Mr. Frank Struben, of Lynnwood, Pretoria, as Vice-Chairman in the place of the late Mr. H. A. Read, whose death we had occasion to deplore in our last issue. Mr. Struben, who is the representative of an old and esteemed Pretoria family, amongst varied interests is an enthusiastic forester, and has been a member of the Association since its beginning. The Association is fortunate in having a gentleman of Mr. Struben's attainments in a directive position on its Executive Committee.

ORGANIZATION OF SAWMILLING INTERESTS.

An article in this issue describes the inauguration and constitution of the newly-formed South African Lumber Millers' and Shook Manufacturers' Association. Such a body, coming into being at a time like this, is endowed with exceptional opportunities for shaping the fortunes of our local sawmilling industry. Although not a co-operative institution, as such, it should be able by co-operation amongst its members to effect much in the way of standardization of industrial practice and marketing methods. As the author of the article admits, development of the industry in the past has been severely handicapped by lack of cohesion.

In this connection, the Secretary for Agriculture and Forestry, in his report on the activities of the Division of Forestry for the year ended 31st March, 1938, drew attention to the position of producers who at that time were concentrating on turning out boxwood as the primary and often the only product in the following terms:

> They (the producers) have to compete with highly organized concerns overseas where the production of boxwood is combined with that of other lines of wood products and with close utilization of mill waste, and where the marketing side is also highly developed. Moreover, the local mill owners, working independently, are apt to concentrate on a few types of boxes with no clear conception of the trend of marketing conditions, which can be gauged only by an intelligence service not yet at their disposal. Incorporated in an organisation, the mills would not only be in a better position as regards manufacturing methods and facilities, but would also be able to work on production schedules controlled according to changing market requirements.

On the basis of the objects of the Association as set out in its constitution there is every reason to expect that the Forestry Service will closely co-operate with it. It is noted that the Director of Forestry was represented at the inaugural meeting and it is understood that he has since accepted nomination as an Honorary Member.

We wish the Association every success.

CAESAR'S BRIDGE.

A correspondent, whose letter appears elsewhere in this issue, raises the point of the botanical identity of the timber used by Julius Caesar in construction of the bridge which in 55 B.C. he threw across the Rhine. Our correspondent cites piles used which were 18 inches in diameter, but seems hesitant regarding the dimensions of certain 40 foot "beams" to which Caesar applies a uniform measurement of two feet. If they had been two feet square, the stems from which they were sawn, under conditions in any degree resembling what would to-day be regarded as normal stocking, must have been at least three feet in diameter at breast height. Even if the measurement applies to diameter, its cited uniformity suggests development under severe competition, which, combined with the fact that these 50 or so massive baulks were felled, cross-cut, slipped to the river bank, and possibly hewn concurrently with actual construction, which occupied no more than ten days, in turn suggests that trees of the size envisaged abounded in the forest concerned. This conjures up, however mistily, a picture of a true virgin forest in Europe 2,000 years ago, which, should any reader who may be familiar with those reaches of the Rhine indicated by our correspondent be able to identify topographically and botanically, might be instructively contrasted with managed forests of the same species existing to-day on sites of similar quality.

IMPORTATION OF TIMBER.

The following Special Press Service Notice has been released for publication by the Department of Agriculture and Forestry. The matter dealt with therein received some notice in these columns in our last issue.

The attention of importers of timber and of others interested is drawn to Regulations 66 and 67 of Government Notice No. 1282 of 1942, issued under the Forest and Veld Conservation Act 1941, which read:

" 66.—From and after the date of publication of these regulations, no person shall introduce into the Union any timber or wood of any description

(a) which has any bark adhering to it, unless the introduction thereof has been specially authorised in writing by the Secretary for Agriculture and Forestry, and except under such conditions as may be determined by him; or

(b) which is infested with insects or infected by fungi.

" 67.—Whenever there is introduced into the Union any timber or wood of any description which at the time of its introduction is infested with insects or infected by fungi, or suspected of being so infested or infected, then whether or not a permit for the introduction thereof has been obtained

(a) such timber may be seized and detained by any officer designated by the Minister, pending enquiry;

(b) the person by whom or on whose behalf that timber or wood was introduced into the Union may be required by the Secretary for Agriculture and Forestry to destroy that timber or wood or to treat it in such manner as the Secretary for Agriculture and Forestry may deem necessary for the destruction of the insects or fungi or for preventing the introduction into the Union or the spread within the Union of such insects or fungi;

(c) such timber or wood may be treated in any manner or destroyed, without compensation, by order of the Minister at the expense of the person having the possession thereof."

In order to prevent expense and delay in the delivery of consignments, importers should stipulate that the timber supplied to them is to be altogether free from bark. The presence of even small pieces of bark is objectionable as injurious insects may be living between the wood and bark. When it is not practicable to ship any kind of timber without the bark, permission for its introduction into the Union must be applied for beforehand. Applications for permits should be addressed to the Division of Entomology, P.O. Box 513, Pretoria.

In the case of shipments which may be found to be infested with insects or attacked by fungi, it depends upon the nature of the organism what action will be taken. Exporters should not risk despatching such timber unless permission for the introduction has been previously obtained.

The importation of debarked timber free from insects and fungi is not affected by these regulations nor is any permit required under them to import such timber.

INVOER VAN HOUT.

Die volgende Spesiale Persdienskennisgewing word deur die Departement van Landbou en Bosbou vir publikasie vrygestel. Die saak wat daarin behandel word, het in heirdie rubriek van ons vorige uitgawe al 'n mate van aandag geniet.

Die aandag van hout-invoerders en ander belanghebbendes word gevestig op Regulasies 66 en 67 van Goewermentskennisgewing No. 1282 van 1942, gepubliseer kragtens die Bos- en Veldbewaringswet 1941, en wat as volg lui:

„66.—Van en na datum van publikasie van hierdie regulasies, mag niemand timmerhout of hout van enige soort in die Unie invoer

(a) as daar bas aan is nie, tensy die invoer daarvan spesiaal en skriftelik deur die Sekretaris van Landbou en Bosbou gemagtig is en dan alleen op die voorwaardes wat hy mag bepaal; of

(b) as dit met insekte of swamme besmet is nie.

,,67.—Indien timmerhout of hout van enige aard, wat in die Unie ingevoer word, tydens invoer met insekte of swamme besmet of vermoedelik besmet is, kan, onverskillig of 'n permit vir die invoer daarvan verkry is al dan nie

(a) daardie timmerhout of hout in beslag geneem en aangehou word deur 'n beampte deur die Minister aangewys, hangende ondersoek.

(b) die persoon deur of namens wie daardie timmerhout of hout in die Unie ingevoer is deur die Sekretaris van Landbou en Bosbou gelas word om dardie timmerhout of hout te vernietig of op die wyse te behandel wat die Sekretaris van Landbou en Bosbou nodig ag om die insekte of swamme te vernietig of die invoer in die Unie of die verspreiding binne die Unie van daardie insekte of swamme te voorkom;

(c) daardie timmerhout of hout op las van die Minister en op koste van die persoon wat dit in sy besit het, sonder vergoeding, op enige manier behandel of vernietig word.''

Ten einde koste en vertraging by die aflewering van besendings te voorkom, moet invoerders stipuleer dat die hout wat aan hulle gelewer word geheel en al sonder bas moet wees. Die aanwesigheid van selfs klein stukkies bas moet afgekeur word, aangesien daar skadelike insekte tussen die hout en die bas mag skuil. Wanneer dit nie doenlik is om enige soort hout sonder bas te verskeep nie, moet toestemming vir die invoer van sulke hout in die Unie vooraf aangevra word. Aansoeke om permitte moet aan die Afdeling Insektekunde, Posbus 513, Pretoria, gerig word.

In die geval van verskepings van hout wat by ondersoek blyk met insekte of swamme besmet te wees, sal die aard van die organisme bepaal watter stappe gedoen moet word.

Invoerders moet dit nie waag om besmette hout te versend nie, tensy toestemming vir die invoer daarvan vooraf verkry is.

Hierdie regulasies raak nie die invoer van ontbaste hout wat vry van insekte en swamme is nie en verg ook geen permit vir die invoer van sulke hout nie.

Division of Forestry's Annual Report.

We were unable to get an independent reviewer to handle the Report of The Division of Forestry for the year ended 31st March, 1941, in our last issue. To rectify the omission, we take over in our current review pages, with due acknowledgment to writer and source, a review by Mr. C. E. Legat which appeared in Vol. 21 No. 1 of the *Empire Forestry Journal,* 1942. Mr. Legat, who was for many years Chief Conservator of Forests for the Union, is a frank and authoritative critic, and no doubt his observations on these reports, which have appeared annually for the last twelve years in the Journal which he previously edited, are studied with interest and benefit by government forestry authorities.

The Journal in War Time.

The size of this issue of the Journal may come rather as a shock to readers familiar with our late comely proportions, which are now circumscribed by the Paper Control Regulations. During the four years of its publication, this Journal has more or less consistently just exceeded the annual quota below which periodicals are not affected by the recently prescribed cuts. Our large issue of April last had already been made up when the regulations were published. Dr. Hey's piscatorial article being part of a consecutive series could not be held up and it and most of the major articles were of too timely a nature for such treatment. It was accordingly decided to let all the copy as made up at the time go to Press, hoping that members would resign themselves to a drastically curtailed October issue to eke out our paper quota for the year. So long as the existing control regulations apply, considerations of paper availability alone should enable two issues of from 80 to 90 text pages each to appear annually.

STATE AFFORESTATION AFTER THE WAR

By I. J. CRAIB

(Chief Forest Research Officer, Division of Forestry.)

THE part which State afforestation might be made to play in the period of post-war reconstruction in South Africa is appreciated by only a negligible number of thinking people. This is due, perhaps, to the fact that professional foresters are notoriously inarticulate in the advocacy of their own achievements. The average taxpayer, furthermore, is not likely to feel ardently about the benefits likely to accrue from State afforestation when the full realization of these benefits will, of necessity, be deferred for 30 to 60 years, the minimum time required to bring average coniferous crops to maturity. There is a danger that the progress which forestry has made in South Africa during the past two or three decades might be dismissed lightly as an interesting, economically sound or even praiseworthy achievement on the part of a State Department. It is, therefore, imperative, relative to the post-war future, to find out whether afforestation might not be made something very much more than merely an " interesting," " economically sound " or " praiseworthy " development. It is particularly opportune, moreover, that the potential contribution which forestry might make to the well-being of the nation should be stated clearly, so that forestry might receive a balanced and merited share in the general national scheme for social, economic and industrial betterment after the war.

During recent years there has been a noteworthy increase in the number of references in the press to the manner in which the State might promote the development of the Union's industrial and agricultural resources. Particular emphasis has been placed upon the development and exploitation of base minerals, upon the establishment of local engineering and manufacturing industries, upon mercantile shipping, water conservation, irrigation, erosion control, rural industry and upon national housing and health schemes. Conspicuously absent, both from press and departmental reports, have been official references to the distinguished contribution which a revised policy of extended afforestation by the State might make to the national economy in terms of employment and industry. A review of the whole timber position in South Africa is warranted because of the notable achievements of the Forest Service (to be detailed presently) and the consistent support which a policy of afforestation has always received from the press, the public and the legislature.

The Natural Forest Resources of the Union

There are few countries in the world more poorly endowed with natural timber resources than is the Union of South Africa. This fact is thrown into relief by a study of the data in Table I given by Zon and Sparhawk (1).

TABLE I.

PERCENTAGE OF TOTAL LAND AREA UNDER FOREST AND *per capita* ACREAGE OF FOREST FOR VARIOUS COUNTRIES.

Country.	Percentage of total land area under forest.	*Per capita* acreage of forest.
Union of South Africa	0·5	0·25
Great Britain	4·3	0·10
Canada	25·0	82·00
Australia	5·8	18·00
New Zealand	25·7	16·00
India	22·7	0·80
Germany	23·8	0·50
France	18·4	0·60
Italy	18·1	0·40
Russia	38·7	4·40
China	6·9	0·60
Japan	53·3	1·20
U.S.A.	28·9	5·20
Brazil	47·5	33·00
Argentine	36·1	32·00

In addition to the unusually restricted extent of the Union's indigenous forest resources, must be considered the facts that the bulk of the timber available from them comprises hardwood species of limited economic importance and that almost 80 per cent. of these forests have already been over-exploited (2). While indigenous timber played a most significant part in the early settlement and subsequent development of the country, there are few foresters who still believe that local indigenous forests should or could be further exploited so as to make a substantial contribution to the future economic and industrial life of the nation. Research upon the silviculture of indigenous forests, particularly during the past twenty-five years, has shown that the present annual wood increment per acre is very low; the possibility of increasing this increment by systematic management so as to bring these forests within the range of economic forestry is, moreover, extremely remote.

The gradual fall (both in the volume of wood in the log and revenue) of production from State-owned indigenous forests during the past 30 years is shown in Table II. These data are taken from the annual reports of the Director of Forestry and exclude the volume and value of hut-building material and firewood.

TABLE II.

WOOD DISPOSED OF FROM INDIGENOUS FORESTS: 1912-13 TO 1941-42.

Five-year period.	Average annual volume of timber in the log sold. cu. feet.	Average annual cash revenue. £
1912-13 to 1916-17	996,000	15,860
1917-18 to 1921-22	1,059,000	22,280
1922-23 to 1926-27	847,000	20,040
1927-28 to 1931-32	928,000	20,330
1932-33 to 1936-37	527,000	10,680
1937-38 to 1941-42	301,000	13,290

For an historical review of the South African indigenous forests, readers are referred to King's informative paper published in the April, 1941, issue of the *Journal of the South African Forestry Association*. A close analysis of the history and potential productivity of these forests clearly indicates that local industry will, in future, have to rely almost entirely upon other sources of timber to meet its requirements. In directions such as water conservation and popular recreation rather than commerce are to be sought the significant contribution to the national interest which indigenous forests might make after the war.

Afforestation with Exotics

More than fifty years ago it was realized that indigenous species offered no scope for commercial afforestation in the Union and that suitable exotic species would have to be found and used for this purpose. Thereafter followed a long period of intensive introduction and trial of hundreds of hardwood and coniferous species selected from all parts of the world with climatic and soil conditions comparable with those prevailing here. Conspicuous success attended this policy. This success is evidenced by the data (the most recent available) presented in Table III, which show the area under plantations of exotic species in the Union as at March, 1937 (3, 4, 5).

TABLE III.

Area in acres of plantations in Union as at March 31, 1937.

Ownership.	Conifers.	Eucalpyts.	Wattles.	Poplars.	Other.	Total.
State	226,197	50,220	38,187	1,438	8,577	324,599
Private and Municipal	58,566	251,164	497,810	23,158	86,993	917,711
Total	284,763	301,384	535,997	24,596	95,570	1,242,310

From this table it will be seen that eucalypts and wattles comprise almost 70 per cent. of the Union's plantations and that of the area under these species only 10 per cent. is State-owned. This is as it should be. Eucalypts and wattles are usually raised as short rotation crops which are admirably suited for private investment. Apart from the production of wattle bark and extract, almost all of which is exported, the great bulk of the wood produced by the eucalypt and wattle industries is consumed by the mines.

Apart from the fact that neither wattles nor eucalypts are suitable for use in a scheme of extensive afforestation by the State, it has been shown elsewhere (6, 7) that no further extension of plantations for the production of mining timber is warranted. Existing plantations of these hardwoods are capable of producing approximately 60,000,000 cubic feet of wood per annum, which is adequate to cope with probable future demands, even if the rate of mining is considerably accelerated. The further planting of eucalypts and wattles on a commercial scale should be undertaken by private enterprise only in the event of the local development on a large scale of wood-pulp, wood-plastics or similar industries which depend upon concentrated supplies of low-priced raw material.

In regard to the production of poplar wood for the match and wood-wool industries, it can be stated unequivocally that there is unlimited local demand at lucrative prices for all the wood of this class that the country could produce. Unfortunately, the site requirements of this genus are so exacting that no very great expansion of afforestation with poplars can be expected. While all suitable sites on State-owned land will assuredly be afforested with poplars, it is from the small patches of privately-owned poplar land, scattered throughout the Union, that the main development in this connection must be looked for.

It is estimated (1) that of the world's total trade in wood, approximately 80 per cent. is composed of conifers, used principally for construction and building purposes, packing materials and pulp. Almost the whole of the world's softwood timber supplies are concentrated in the northern hemisphere. The hardwoods from temperate regions, used for staves, sleepers, furniture, cabinet work and other special purposes, constitute about 18 per cent., while tropical hardwoods, used mainly for furniture and veneer woods, are only 2 per cent. of the total. The view that the still abundant supplies of tropical hardwoods will ultimately replace the softwoods of commerce to an appreciable extent does not warrant serious consideration in view of the basic unsuitability of these hardwoods for the purposes under consideration.

It is therefore the local production of long-rotation coniferous timber that constitutes the main task of forestry in South Africa if a considerable measure of independence of overseas supplies is ever to be achieved. As the financial returns from afforestation with conifers are relatively deferred, the main responsibility for afforestation in this category devolves upon the State.

State Afforestation with Conifers

The State has already achieved a considerable measure of success with coniferous species. Up to the present approximately 273,000 acres have been afforested by the Department and, as shown in Table III, an additional area of about 60,000 acres has been afforested with conifers by private and municipal enterprise. *Pinus insignis* from California, *P. caribaea* from the southern states of the U.S.A. and Central America, *P. patula, P. montezumae* and *P. pseudostrobus* var. *tenuifolia* (widely known as *P. teocote*) from Mexico, *P. pinaster* from south-western Europe, and *P. longifolia* from India comprise the main actual or potential bases of such commercial afforestation in South Africa. All these species may be regarded as being acclimatised to one or another well-defined region in this country. Since 1920 State afforestation with conifers has proceeded at the accelerated rate of 12,000 to 14,000 acres per annum, and only in the past two years has this rate been drastically cut owing to current exigencies.

This policy has had a pronounced impact upon industry. During the past financial year the Department produced, almost exclusively from the thinning of immature plantations, 10,000,000 cubic feet of sawlogs. If to this is added the 3,000,000 cubic feet of sawlogs which it is estimated were made available from the clear-felling or thinning of small, privately-owned plantations during the same period, it will be seen that a total volume of 13,000,000 cubic feet of softwood sawlogs was contributed from local sources, to the maintenance of industry during a period of critical shortage of timber in this category. Working upon a 40 per cent. factor of conversion from logs of immature size (50 per cent.

for logs of mature size) to deals, scantlings, and shook lumber, this total represents approximately 5,200,000 cubic feet of sawn timber.

In order to appreciate the significance of these data it will be necessary to consider them in relation to past and possible future imports into the Union of comparable coniferous softwoods.

Softwood Requirements of the Union

Table IV gives approximate estimates, for the past 30 years (in 5-year periods), of the average volumes of softwoods in various categories imported into the Union annually from overseas. The data are derived from statistics published by the Department of Customs and Excise.

TABLE IV.

Volumes in millions of cubic feet of coniferous wood imported into the Union annually.

Five-year period.	Unmanufactured and partly manufactured coniferous wood.	Flooring and ceiling.	Agricultural and industrial boxes.	Plywood pulpboard, woodmeal and woodwool.	Total average annual imports.
1910-1914	9	3·0	0·7	—	12·7
1915-1919	4	1·0	1·2	—	6·2
1920-1924	7	2·0	1·5	—	10·5
1925-1929	10	3·0	2·0	·1	15·1
1930-1934	12	2·5	2·0	.3	16·8
1935-1939	20	4·0	3·0	1·0	28.0

Inferences of considerable importance may be drawn from these data. The 5,200,000 cubic feet of sawn softwoods produced in the Union during the past year comprise approximately 19 per cent. of the average volume of softwoods imported into the Union during the five immediate pre-war years, and probably more than half the current reduced consumption of sawn softwoods. In view of the fact that the local saw-milling business is barely seven years old, this achievement is truly remarkable. It should, however, not be taken out of its context. Scores of small sawmills have been established during the past two years owing to the marked rise in the value of standing softwood timber (which has made additional supplies available) and in the price of softwood boxes and building material. A considerable proportion of the logs supplied to these mills is derived from the clear-felling of small, privately-owned woodlots. The gradual depletion of such sources of supply inevitably means that many of these mills will sooner or later go into liquidation and that, at least for a temporary period after the war, it will not be possible to maintain the present rate of production.

It is estimated that 50 per cent. of the log volume is lost during conversion into the marketable commodities enumerated in Table IV. This means that an equivalent of 56,000,000 cubic feet of softwoods in the log were imported into the Union annually during the pre-war five-year period. The table shows, moreover, that in the 30 years since Union, local consumption of imported softwoods has risen from 12·7 to 28 million cubic feet, or approximately at the rate of 4 per cent.

per annum. As few would care to dispute the view that only now is the Union on the threshold of a period of accelerated economic and industrial expansion, it may be assumed that this rate of increase in softwood consumption will be maintained at least during the next 50 years.

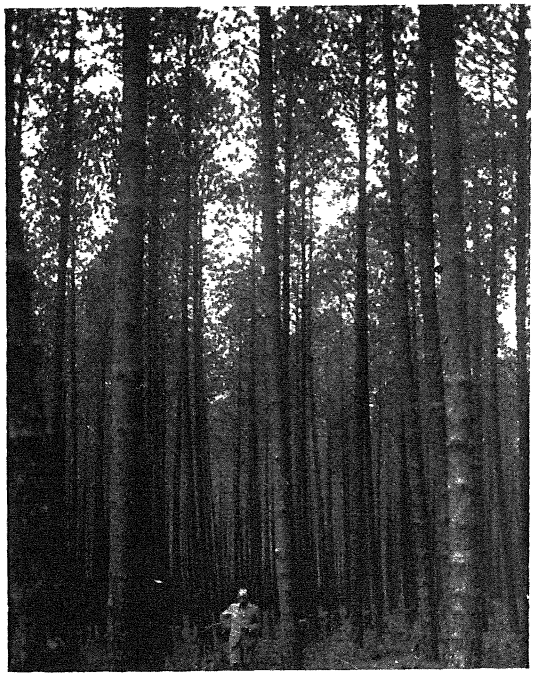
This forecast means that during the next 50 years the local consumption of softwoods will rise by 200 per cent. or to 168,000,000 cubic feet in the log. The pre-war consumption of locally-produced softwoods (building material, boxes, poles, etc.) and imported paper, cardboard and pulp products manufactured from softwoods, is conservatively assessed (from official statistics) at 10,000,000 cubic feet in the log. This must also be increased by 200 per cent., bringing the total estimate of the log volume demanded annually by the Union, 50 years hence, to approximately 200,000,000 cubic feet. Assuming that there will be only a small rate of increase in the population of the Union during the next 50 years, this estimate allows for a total annual per capita consumption of wood of only about 20 cubic feet (including wood from all local sources) as opposed to 228 for the U.S.A., 129 for Sweden, 66 for Russia, 32 for Germany, and 17 for Great Britain (1).

Present Policy of State Afforestation

It has already been stated that up to the present the Department has afforested 273,000 acres with conifers. The 1937 Annual Report of the Director of Forestry states that if the (then) rate of afforestation of 16,000 acres per annum is maintained, all the suitable land now owned or likely to be acquired by the State will be afforested in a twenty-five year planting programme. He states, furthermore, that while no opportunity of acquiring afforestable land at reasonable prices is neglected, he does not expect that the Department will succeed in eventually securing additional land for a more extended programme.

It will next be necessary to ascertain, as far as possible, the extent to which the fulfilment of current policy will ultimately meet the assessed national requirements for softwood timber. In a comprehensive survey, published by the writer three years ago (8), of the productive capacity of actual and potential State-owned coniferous plantations, it was estimated that on the completion of the planting programme a quarter of a century hence, the total area under conifers would be approximately 590,000 acres (eucalypts and other hardwoods in fire-belts comprising 10 per cent. of the area still to be afforested) and that a stabilised annual yield of about 72,000,000 cubic feet of logs would be obtained from this area from about 1980 onwards.

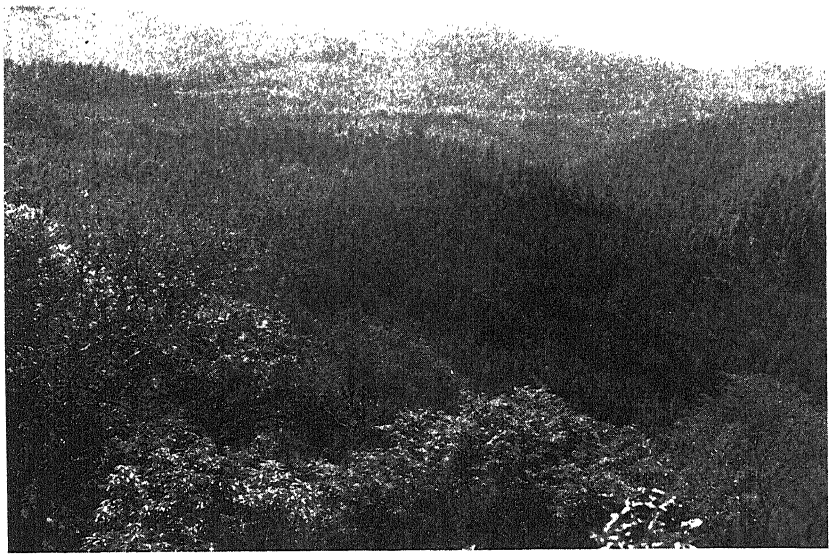
It is shown in Table III that an additional area under conifers, approximately one-fourth of that under State ownership, is privately owned. Assuming that this ratio between private and State-owned pine plantations is maintained in future, it may be concluded that under present policy South Africa will be capable of producing only 90,000,000 cubic feet or less than half of the 200,000,000 cubic feet required by the nation 50 years hence. As the mean annual volume increment of wood per acre is assessed at approximately 120 cubic feet (8), it would, on this basis, take 1,600,000 acres of conifers to supply the anticipated demand for softwoods at the time stipulated. As private enterprise is likely to afforest not more than 150,000 acres (i.e., 25 per cent. of the current State programme) during this period, there remain 1,450,000



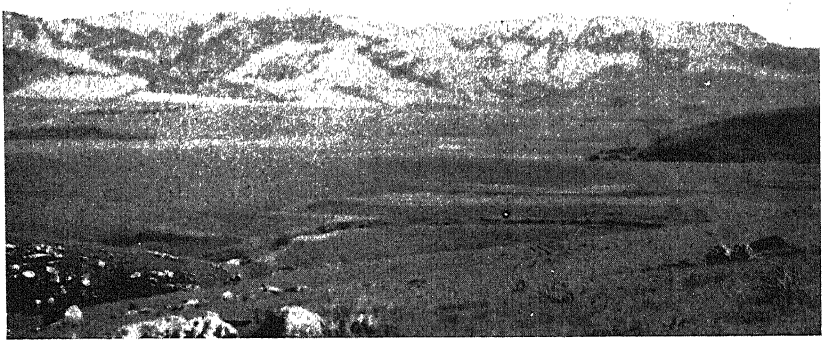
Stand of *Pinus patula* at Woodbush (Transvaal), 21 years old. Number of trees per acre 225; mean height 90′; mean diameter at breast height 13·1″; total volume produced per acre 11,440 cu. ft.; volume standing 5,214 cu. ft.; mean annual volume increment per acre 532 cu. ft. At £23 per standard this site is capable of producing £37 worth of unmanufactured sawn products per acre per annum; its productive capacity is well above that of average first quality land.



Stand of *Pinus insignis* at Tokai (Cape Province), 17 years old. Number of trees per acre 220; mean height 93′; mean diameter at breast height 12·2″; total volume produced per acre 8,987 cu. ft.; volume standing per acre 6,414 cu. ft.; mean annual volume increment per acre 530 cu. ft. The timber shown here, and in the photograph on the left, is worth about £300 per acre standing at current stumpage values; normally the value of such timber would be about £100 per acre standing.



Cool southerly and easterly slopes of selected mountain ranges, where the rainfall is high and the soil deep, provide ideal conditions for afforestation. Above is such an area afforested with conifers; note the indigenous forest in the foreground and the eucalypt fire-belts on the ridges.



Timber production in this type of country will create more national employment, industry and wealth than any other form of use for such land. Patches of indigenous forest usually indicate the suitability of such areas for afforestation with exotic conifers.

acres as the justifiable goal for State afforestation, as opposed to the 590,000 acres to which it is now committed.

It will next be necessary to determine whether or not the available facts warrant a drastic revision of current afforestation policy.

Wood Increment per Acre and Land Values

It is not the purpose of this paper to assess the nett profit likely to accrue to the State from a programme of afforestation. This will depend upon a great many variable factors which cannot now be forecast with precision as they will be governed largely by international social and economic factors over which this country will have little control or even by local State policy over which the Forest Service will have little control. The profitability of State afforestation will, for example, fluctuate between wide limits depending upon whether the State employs european or native labour in the plantations and sawmills under its jurisdiction. From the particular angle of approach adopted here, the processes of timber production and sawmilling are regarded as inseparable and it is, therefore, a matter of indifference whether the wood produced in State plantations is milled and marketed departmentally or by private enterprise. The data, to be given later, will, therefore, deal with gross income likely to be available to the nation as a whole from all primary and secondary industries founded upon the proposed policy of afforestation by the State, and will not concern themselves with probable departmental revenue or profits. Gross income, for any industry which can be run at a profit, is the only valid yardstick by which its contribution to the wealth of the nation can be measured. This view is emphasized by the fact that a sum of money equal to the annual gross income from all potential South African sawmills would have to leave the country annually to pay for the production and transport of similar commodities from overseas were no plantations or sawmills to be established here.

If the effects of trade booms and depressions are ignored, it may be stated categorically that during the past century or longer there has been a gradual but significant rise in the world price of timber. With the depletion of supplies which will result from the mining of the virgin forests of the world now in progress, and with the increased demand which will result from the industrialization of backward peoples, it is safe to surmise that the price of lumber (excluding periods of abnormality like the present) will continue to rise. Even if the view that vast supplies of virgin timber (as in Russia) are still available, is conceded, the trend in price will nevertheless be upward owing to increased inaccessibility and relatively higher costs of transport. All countries will have to rely increasingly upon home-grown (as opposed to virgin) timber supplies, and it is improbable that the great timber-exporting countries, which have a high *per capita* consumption of wood, will ever have an appreciable surplus of home-grown wood available for export. Under any system of fair and controlled world trade, as envisaged by the Atlantic Charter, the future position of the South African softwood producer will tend to become more favourable *vis a vis* his competitor, the overseas exporter of timber. It will doubtless be necessary to deal more fully with the reasons supporting this opinion.

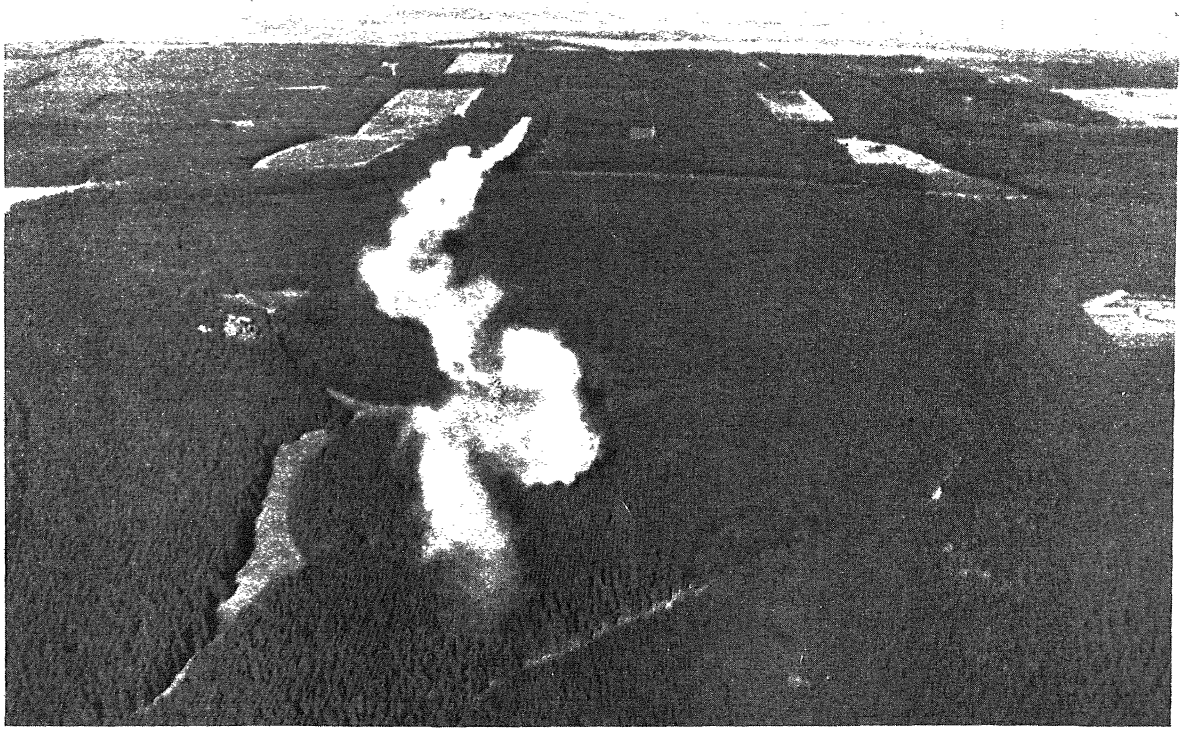
Despite the very limited amount of first quality forest land available in South Africa, the productivity of such land relative to world standards

is phenomenally high. This is due to an unusually favourable combination of factors comprising rainfall, temperature, humidity and soil, as well as to silvicultural technique developed locally. The mean annual increment of wood per acre in South Africa averages from 40 to 390 cubic feet, depending upon site quality and species (8). A suitable selection of fast- and medium fast-growing pines on land which is a mean between first and second quality may be estimated to yield a mean annual wood increment of 280 cubic feet (8). Compare with this the mean increments for the following countries (1): Germany, where the practice of forestry is most advanced, 50 cubic feet; Sweeden, 37 cubic feet; Russian, 35 cubic feet; Canada, 7 cubic feet; U.S.A., 13 cubic feet. While these data apply to the entire commercial forest areas of the countries concerned and would have to be raised appreciably for selected sites under intensive management, they nevertheless indicate the wide margin of increment, due mainly to climate, which favours the local producer of softwood timber. In other words, it will take at least two to ten times as long to produce sawlogs of a given mature size in the colder countries of the northern hemisphere as it takes to produce logs of similar dimensions in selected local areas.

The difference between the profitability of afforestation with conifers on first quality sites as opposed to third quality or even to second quality sites is surprisingly large. The cost of afforestation and subsequent silvicultural management for the three site qualities is not greatly different. The higher cost per acre for the slashing of weeds during the first two years on first quality sites is usually compensated for by the lower costs of soil preparation and replacement of trees which fail due to adverse soil and climatic factors.

The Government contract price for unplaned deals and scantlings (9" x 3", 6" x 3", 4½" x 3", 4½" x 1½" and 3" x 2") f.o.r. Durban, Port Elizabeth and Cape Town from July, 1938, to June, 1939, averaged £23 per standard (165 cubic feet). As there was keen competition for the timber markets of the world during the period quoted, £23 per standard (f.o.r.) may be regarded as the lowest average price at which it will be possible in future to obtain unmanufactured softwood timber from overseas under conditions of fair world trade (the current price is £75 or more per standard). Assuming, furthermore, that there will be no increase in this price of £23 during the next fifty years and that the loss in conversion from logs to unplaned building material is 50 per cent. (of the total volume in the log harvested, 80 per cent. will be from the final felling and 20 per cent. from thinnings), the gross annual yield per acre in terms of both volume and value from the various site qualities and species (8) is shown in Table V.

These data show that a mature and properly-constituted forestry project is capable (subject to the validity of the forecasts made) of producing, in perpetuity, a gross annual income from sawn products of £27 per acre on first quality sites afforested with fast-growing pines as opposed to only £3 per acre on third quality sites afforested with slow-growing pines. In view of the fact that the cost of production per cubic foot of wood in the log on first quality land is only a small fraction of this cost on third quality land (the costs per acre are not very different), the element of profit in the former as opposed to the latter is immensely greater than is indicated by the ratio of £27 to £3 or 9 to 1.



Dusting *Pinus patula* with calcium arsenate from the air. See defoliated stand overleaf.



There are risks in timber production. Above is seen a young plantation of *Pinus patula* at Jessievale, Transvaal, completely defoliated by the larvae of *Euproctis terminalis*. Usually, however, scientific research is able to devise measures which reduce losses to a minimum, and overleaf will be seen plantations of *Pinus patula* at Jessievale being dusted by aeroplane with calcium arsenate to control this insect.

TABLE V.

EFFECT OF SITE QUALITY AND SPECIES ON GROSS ANNUAL YIELD PER ACRE.

Item.	Fast-growing conifers (*P. patula* and *P. insignis*).	Medium fast-growing conifers (*P. caribaea*, *P. montezumae*).	Slow-growing conifers (*P. pinaster*, *P. longifolia*).
First quality sites:			
Rotation period (years)	30	30	40
Mean annual volume increment per acre (cu. ft.)	390	290	110
Gross annual value of sawn products per acre, f.o.r.	£27	£20	£8
Second quality sites:			
Rotation period (years)	40	40	50
Mean annual volume increment per acre (cu. ft.)	215	160	80
Gross annual value of sawn products per acre, f.o.r.	£15	£11	£6
Third quality sites:			
Rotation period (years)	50	50	60
Mean annual volume increment per acre (cu. ft.)	80	60	40
Gross annual value of sawn products per acre, f.o.r.	£6	£4	£3

So far, only the productive capacity of land has been considered. The effect of distance to rail is equally striking. Assuming, as heretofore, that high quality land has a mean production capacity of 280 cubic feet of wood per acre per annum in perpetuity, it means that each year each acre will produce 140 cubic feet of sawn boards (loss in conversion is 50 per cent.). As each seasoned cubic foot weighs at least 30 pounds, each acre will produce at least 2 tons of sawn wood which has to be transported to rail. As transport costs approximately 6 pence per ton mile, it means that for each additional mile the plantation is situated away from rail, the additional cost of transport per acre per year is one shilling. This amount, capitalised at 5 per cent., means that for each mile a plantation is nearer to rail, the value of its land per acre will rise by £1. This figure of £1 applies to plantations which are going concerns. As there are no coniferous plantations in South Africa which have already reached their peak of sustained production, it will be necessary to include the effect of compound interest at 5 per cent. on the price of land for 30 years, which is the time necessary to bring a plantation to its maximum production. As money at this rate of interest quadruples itself in 30 years, the discounted value of the £1 referred to is 5 shillings. These data show not only that the value of high-production forest land increases by approximately 5 shillings per acre for each mile that it is nearer to rail, but also that its value for afforestation will soon drop to zero if its distance to rail is excessive.

PURCHASE OF AFFORESTABLE LAND BY THE STATE

The Department has, in the past, acquired land suitable for afforestation by the transfer of Crown land, by exchange and by purchase.

The area of land held by the Crown and potentially suitable for afforestation because of favourable site factors and accessibility is not extensive, nor will it be possible to augment, to any extent, the afforestable area through the exchange of land. If the current policy of afforestation by the State is to be drastically revised and extended, then it must be upon the basis of additional land acquired by purchase.

In the past the Department has strictly adhered to the unwritten policy that forest land should be cheap land. It has amply been shown here that the price of forest land, when divorced from the productive capacity and accessibility of that land, has no meaning; poor, cheap land even when near rail is likely to prove economically marginal—rich land reasonably distant from rail and relatively expensive is likely to prove highly profitable. These conclusions and their practical demonstration in current South African forestry are so well known to thinking foresters that it is quite remarkable that the departmental policy of paying a low and arbitrarily-fixed maximum price for land has been allowed to persist to the present day. It has stifled the acquisition by the State of large areas of land notably suited for afforestation and has prevented the consolidation of extended blocks of land, only parts of which now comprise forest reserve.

If the ceiling price at which the State is permitted to acquire land, notably suited for afforestation, is raised, the State will find itself peculiarly well placed to purchase land of the type under discussion. As at least 2,000 acres of plantation are required to maintain a sawmill of minimum economic capacity in sustained production, the Department will be in a position to acquire smaller units of land now attached to, or in the vicinity of, one or other of 150 forest reserves selected from the 300 separate reserves under its ownership. Having these foci to work from, a policy of land acquisition by the State would be considerably facilitated.

There is no question of suggesting here that the State should be permitted to acquire land for afforestation at prices above market levels, or that the State should take any action which would tend to accelerate the rate at which land values have risen in the past. The recommendation is, rather, that the State should, in future, be allowed to compete for the purchase of land in areas where the price of land has already climbed above a set limit which is known to be unreasonably low and arbitrary.

Revision of Afforestation Policy

Forestry in South Africa has already passed beyond the experimental phase. The results achieved during the past 50 years, particularly when analysed against the background of the likely world timber position during the next 50 years, warrant a courageous and drastic revision of current afforestation policy. The demand for home-grown softwood timber, relative to the country's capacity to produce it, is almost unlimited. There is no evidence which suggests that because of one or another factor, be it technical, industrial or economic, the State should restrict itself to the completion of the modest programme of afforestation to which it is now committed.

For the reasons given it is strongly recommended that the State should, during the next decade, plan to acquire an additional 450,000

acres of high-quality afforestable land and that, after the war, the average pre-war rate of afforestation of 15,000 acres per annum should be increased to 45,000 acres per annum.

As approximately only 10 per cent. of the area to be afforested should comprise hardwoods used in belts for purposes of fire protection, the completion of the programme envisaged will result in the State's holding coniferous plantations approximately 1,000,000 acres in extent. Were afforestation to proceed at the suggested rate of 45,000 acres per annum, planting would be completed in approximately 16 years.

It has been stated that the mean annual wood increment per acre of the afforested and afforestable land now held by the Department is assessed at 120 cubic feet. If only first and second quality land is purchased in future, the assessment of the mean increment for the additional land might legitimately be raised to 280 cubic feet (due as much to change in selection of species as to improvement in site quality). The annual production capacity, 50 years hence, of the total programme including both State and privately-owned plantations, would then be approximately 200,000,000 cubic feet in the log, which is equal to the previously estimated local demand for softwoods at this date.

The usual aim of forest management is to attain an even gradation of age-classes in each complete forest unit so as to permit of the clear-felling of an equal area (if of uniform quality) annually in perpetuity from the time the area planted in the first year matures. Reduced to its simplest terms this means that if a 3,000 acre plantation is run on a 30-year rotation and afforested at the rate of 100 acres per year, then normality in age-class distribution will be achieved in the 30th year. This technical objective in forestry has considerably influenced and slowed down the rate at whch the State has in the past afforested many of the plantation units under its control. In actual practice the application of this policy has marked disadvantages. Under normal conditions logs of small size, obtained from thinnings, have little or no value until their volume aggregates approximately 250,000 cubic feet annually, which is the minimum volume required to maintain an economic sawmill unit. This means that if thinnings from the tenth year onwards are to be utilized, the minimum rate of afforestation for high-production land should be approximately 500 acres per year in cases where no older plantations are available in the vicinity from which additional log supplies might be drawn. The success achieved by the early establishment of sawmilling industries in areas rapidly afforested by european labour since the last war amply demonstrates the desirability of bringing afforestable land under profitable log production in the shortest time possible.

A normal forest, moreover, is a theoretical concept which assumes not only an even distribution of age-classes but also the same wood production capacity for each age-class. In view of the variety of site qualities and species encountered in any well-planned coniferous forest and the unequal effect of factors like pest, drought and wind and genetic research on the various site qualities or species, the objective of normality is likely to remain permanently unattainable.

For these reasons it is specifically recommended that as far as possible afforestation should be completed in each unplanted unit area upon the basis of a five-year planting programme. Thinning schedules could then

be adjusted to five-year periods, which would enable sawmills to remain in continuous operation from the 10th year onwards in the case of the better site qualities under discussion. The sooner the afforestation programme of the State is completed, the better. The timber requirements of the country are so urgent and the arguments supporting the rapid building up of employment and industry so weighty that the acceleration of afforestation from the pre-war annual rate of 15,000 acres to the proposed post-war annual rate of 45,000 acres is amply warranted despite the objections which may legitimately be raised against such a change in policy.

Effect of Proposed Revision

The cost of afforestation and technical maintenance (including overheads), until the 10th year from the time of planting, when it is estimated the revenue per acre will exceed the expenditure per acre, is assessed at £10 per acre if native labour is used and £25 per acre if european labour is used. Taking the average figure between these extremes, namely, £17 10s. per acre, the completion of the additional programme proposed, to such time as each acre is self-supporting, is therefore likely to be less than £10,000,000, including the cost of the land. This programme, financed from loan funds, would mean only a modest burden on the present generation of taxpayers, particularly as the expenditure would be spread over a period of a quarter of a century.

As stated previously, the additional area (400,000 acres) afforested with pines should have a sustained yearly production capacity of 110,000,000 cubic feet of sawlogs. This, in terms of sawn material at £23 per standard, equals a gross annual income to the nation (not necessarily to the Department) of £7,600,000, or £2,600,000 more per annum than that for the current afforestation programme which (being 600,000 acres) is 50 per cent. greater in terms of area than the additional planting proposed; the anticipated gross annual income (plantation and mill) per acre for the additional scheme is likely to be £19 as opposed to £8 10s. for the existing one.

The animal and crop production capacity of South African land is low. The production capacity of afforestation as envisaged here is a notable exception to this general rule. There are few agricultural industries which, upon results achieved during the past 50 years, can afford to plan future expansion upon the basis that the ultimate gross annual income may conservatively be estimated at £19 per acre in perpetuity.

In European countries the policy of restricting afforestation to poor and cheap non-agricultural land is widely applied; the best land is reserved for pasturage and agricultural crops. This concept has strongly influenced local policy and demands revision in the light of local circumstances. There the price of productive land is relatively exorbitatnt, here modest; there wood increment is low, here high; there timber is cheap and abundant, here expensive and scarce; there the best forest land can be more profitably exploited under other forms of land use, here, in the best forestry areas, forestry is more lucrative than any competing form of land use. This last statement may require brief elaboration. In the high rainfall mountain areas, which are particularly well suited for afforestation in South Africa, the topography

and leached acid soils preclude the establishment of intensively-managed grazing or agricultural projects. The value of land in such areas has risen only because of the profits made from the production of timber. In such watersheds long-rotation forestry is the optimum form of land use, not only from the view of production and profitability, but also from the view of soil amelioration and conservation, erosion control and regulation of stream flow (9).

It may roughly be estimated that 50 employees are permanently required to run each 1,000 acres of coniferous plantation, half in the field and half in the sawmill. The additional programme advocated would, therefore, lead ultimately to the permanent employment of an additional 22,000 daily-paid employees.

Conclusion

The Forest Service now controls 3,460,000 acres of land, 375,000 of which have already been afforested (with conifers and hardwoods) and 314,000 acres of which are still suitable for afforestation. The scope of the Service is so wide and its function is so diversified that it is almost impossible to determine, with any degree of precision, the proportion of its annual expenditure which might justifiably be allocated against the existing State-owned plantations. The resources of the Division of Forestry, in terms of both men and money, are generously devoted to activities which are not revenue producing except in a broad national sense. The conservation of watersheds, erosion control, drift-sand reclamation, the patrolling, protection, improving and administration of large areas of indigenous forest, research on forest influences, forest products and silviculture, forest education, propaganda and general advisory work, may all be regarded as falling legitimately within this category.

Since Union, the gross expenditure on forestry by the State has been approximately £12,500,000 (from both revenue and loan funds). The cash revenue (excluding gratis issues) during this period has been approximately £4,000,000. For the nett expenditure of £8,500,000 (exclusive of interest) the State has built up a vast national asset which already provides employment for nearly 15,000 daily-paid employees in State-owned plantations and in State- and privately-owned sawmills. For several departmental plantations cash revenue already exceeds gross expenditure despite the fact that normal clear-felling is only now about to commence. If the State invests £10,000,000 in forestry, additional to its current commitments, along the lines indicated, it may confidently look forward, 50 years hence, to its present potential production capacity of softwoods being increased by 150 per cent., to its providing raw material for wood-using industries (excluding all hardwoods and privately-owned softwoods) with a total output worth £12,600,000 per annum (pre-war wood imports had already risen to £5,000,000 per annum), and to its providing employment, directly and indirectly, for 100,000 employees or for the support of half a million souls. The timber thus produced should be sufficient to maintain 180 mills as large as the largest existing local mill (1,000,000 cubic feet annual capacity), in permanent production. Furthermore, 50 years hence, the total cash revenue should so far have exceeded the total gross expenditure that

the Union's forestry programme, as outlined, far from being a burden upon the taxpayer of the future, is actually likely to provide a source of substantial nett revenue for the support of the State. The ultimate effect upon the Union's balance of trade with overseas countries should be equally impressive.

No factor can now be foreseen which will make it either inexpedient or impossible to carry this plan to finality. The requisite technical information is already available; the risks from fire, climatic factors, insects and fungi in this country are no greater than similar risks inseparable from investments in forestry elsewhere; the existing departmental framework will readily carry a trebling of the pre-war afforestation rate, provided that the rate of increase is not too sudden; suitable land is available provided that the policy of having to acquire it at current market levels, which may be substantially higher than the prices hitherto paid by the State for such land, is accepted as the *sine qua non* to the fulfilment of the programme.

Because of the period of time required to bring a forestry project to maturity, afforestation provides, perhaps, the most notable example where the onus for the development of the natural resources of a country in this respect should, of necessity, devolve upon the State. Wood is a basic raw material and, because of its low price, is the universal substitute for all the materials which compete with it. The demand for softwood timber and pulp is virtually unlimited. A survey of the timber position of the world urges a courageous and drastic revision of local policy. The recommendations here made constitute an opportunity and a challenge for State afforestation after the war.

References

1. Zon, R. and Sparhawk, W. N.: Forest Resources of the World. McGraw-Hill Book Co., N.Y. 1823.
2. King, N. L.: The Exploitation of the Indigenous Forests of South Africa. *Jour. S.A. For. Assn.*, No. 6. 1941.
3. Official Year Book of the Union, No. 21. 1940.
4. Division of Forestry Annual Report for the Year ended 31st March, 1938.
5. Craib, I. J.: South African Wattle Bark and Wattle Extract with special reference to the American Market. *Jour. S.A. For. Assn.*, No. 6. 1941.
6. Division of Forestry Annual Report for the Year ended 31st March, 1940.
7. Stephens, R. P.: Mining Timber in South Africa with special reference to Wattle Silviculture. *Jour. S.A. For. Assn.*, No. 4. 1940.
8. Craib, I. J.: Thinning, Pruning and Management Studies on the Main Exotic Conifers Grown in South Africa. Dept. of Agr. and For. Sci. Bull. 196. 1939.
9. ————: Afforestation *versus* Water Conservation. *The Forum*, July 4, 1938.

A SEMI-EVERGREEN FORM OF LOMBARDY POPLAR

By O. S. H. REINECKE

(Professor of Pomology, University of Stellenbosch)

and

C. L. WICHT

(Forest Research Officer, Jonkershoek, Stellenbosch.)

SHELTER-BELTS of Lombardy poplars are freely used in the irrigated zone of the Rio Negro Valley of the Argentine to protect apple and pear orchards from persistent westerly winds which blow during spring. Most of the poplars are deciduous, shedding their leaves after the first autumn frosts. While visiting this region in the autumn of 1938, in quest of deciduous fruit trees on behalf of the South African Department of Agriculture and Forestry, the senior author noticed some poplars, which were not wholly deciduous; they were carrying frost-injured, brown, parched leaves, the petioles of which had not abscissed in the usual manner following upon cold frosty weather. Locally these were known as Chilean Lombardy poplars. Cuttings from such trees—kindly supplied by Mr. A. MacDonald, Resident Manager of the experimental farm, Cinco Saltos, belonging to the Great Southern Railway—were subsequently introduced into South Africa, because it was felt that this variety might be useful for shelter-belts in the mild coastal area of the south western Cape Province. At the Cape the variety has grown extremely vigorously and so far has proved to be almost completely evergreen.

Cape horticulturists have for many years been aware of the beneficial effects of shelter which will protect plants from excessive insolation during the winter. Owing to the tempering influence of the sea and a general lack of frost many fruit trees and shrubs fail to get the amount of chilling required for their winter rest. A tall shelter-belt on the north and north-west sides would protect such plants from the direct rays of the sun and thus reduce excessively high temperatures. Sheltered fruit trees emerge from the winter rest earlier and more uniformly; buds on exposed trees are slow in opening, flowering is often many weeks late, and it frequently happens that only a small percentage of the fruit buds set. This functional disorder has been described as " delayed foliation."

Many varieties of choice trees and shrubs, which require more severe winters, cannot at present be grown successfully at the Cape. Attempts to obtain varieties better suited to the climate by importation, selection and breeding, have been partially successful, and this work is being continued. Meanwhile a shelter-belt of fast-growing, evergreen trees of good height will serve a useful purpose by protecting susceptible plants from this type of winter injury, and it is for this use that the Chilean Lombardy is being tried.

The oldest trees of this variety of poplar in South Africa are four years old and these have been repeatedly cut to obtain material for further propagation. The variety has, therefore, not yet been sufficiently well tested for it to be recommended for extensive planting. The purpose of this note is merely to place on record the introduction of a promising new tree species which may later prove to be of considerable value.

The initial rate of growth from unrooted cuttings has in most cases been excellent. In the Jonkershoek nursery cuttings produced shoots from six to nine feet high in one year. Cuttings of the tree known in South Africa as *Populus deltoides* Marshall var. *missouriensis* Henry (Schiemer, 1940) growing in adjacent beds, although set out earlier, showed much poorer growth. Cuttings of the most vigorous of the Oxford hybrid poplars introduced from the United States of America, were were set out at the same time as the Deltoides, also grew more slowly. The Oxford hybrids, the Deltoides and the semi-evergreen Lombardy are now being tested in a properly laid out field trial at Jonkershoek. At the Experimental Farm, Welgevallen, of the Stellenbosch-Elsenburg College of Agriculture, cuttings about nine inches to one foot apart grew twelve to fifteen feet in two years (see Fig. 1). At Vleermuisklip on test plot No. 101 at the Olifants River Irrigation Scheme, rooted cuttings used for a wind-break have grown ten to twelve feet in one year. They are standing at an espacement of ten feet in two staggered rows ten feet apart on good, deep, alluvial soil which is irrigated (see Fig. 2).

Apart from its fast growth and non-deciduous nature the Chilean Lombardy poplar has other characteristics which recommend it as a shelter-belt tree. The root systems of poplars encroach less upon the orchard land than those of other evergreen trees such as gums or pines, and consequently the adjoining fruit tree rows are less adversely affected in their growth. The poplar is also less dense and therefore is less liable to harbour pests and serve as a breeding ground for insects. It is very easily propagated. Cuttings taken in July or August in the south-western Cape Province root very readily, and if they are put out direct into the field on suitable sites there are practically no failures. Young shoots are developed shortly after the cuttings are put in the ground and growth is apparently continuous throughout the year. The poplar will have to be restricted to relatively moist sites. On drier hillsides other shelter-belt species will still have to be used. Indications are, however, that it is less exacting as to growing site than the deciduous Lombardy and other poplars.

The Chilean Lombardy might also possibly be used in genetic experiments with the object of finding a poplar which will produce timber more suitable for use in the match industry than that of the Grey poplar—*P. canescens* Smith—or the Deltoides, the species at present grown in the south western Cape Province. Evergreen trees with no distinct rest period are better suited than the deciduous ones to the milder parts of the winter and constant rainfall areas. By crossing the Chilean Lombardy with *P. nigra* L., and other related poplars, a semi-evergreen, fast-growing, relatively hardy, but less branchy form may possibly be obtained that might be superior to the poplars grown at present.

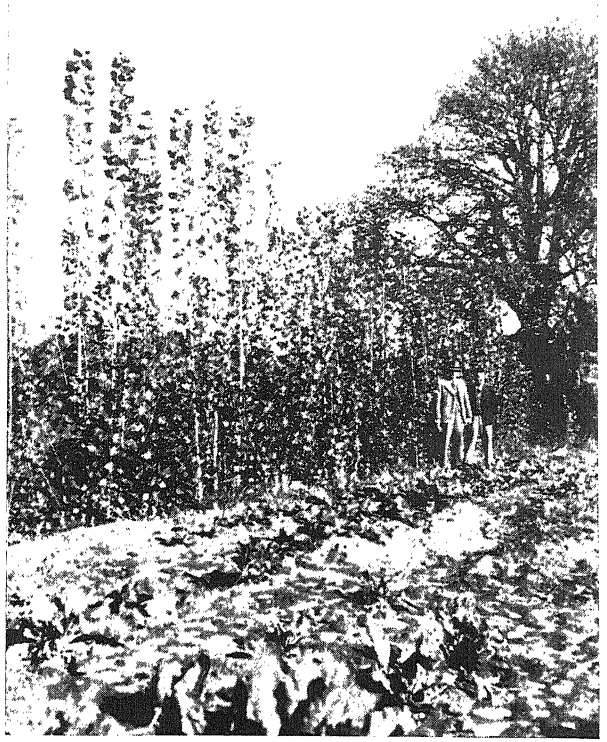


FIG. 1.—Two years' growth of unrooted cuttings of Chilean Lombardy poplar at Welgevallen, Stellenbosch. August, 1942.



Photo by Mr. Daneel du Preez.

FIG. 2.—One year's growth of rooted cuttings of Chilean Lombardy poplar at Vleermuisklip, Olifants River Irrigation Scheme. July, 1942.

Botanical Note

Two fastigiate varieties of the Black Poplar—*Populus nigra* L.—are known as Lombardy poplars. They are *P. nigra* L. var. *italica* du Roi., and *P. nigra* L. var *plantierensis* Schneider (Cansdale, 1938; Houtzagers, 1937). The former is widely cultivated in South Africa as an ornamental and shelter-belt tree. It is not known whether the variety *plantierensis* has ever been introduced. This variety is distinguished from variety *italica* by pubescense of the young twigs and petioles of the leaves. The petioles are also more typically red-brown. According to Houtzagers it is almost certain that this variety is a cross between male *P. nigra* L. var. *italica* du Roi and female *P. nigra* L. var. *betulifolia* Torrey, which occurred in the nursery of Simon Louis in France in 1868. The distinguishing features mentioned above are derived from the female parent. Female and male trees are found. It is possible that the variety *italica* arose as a mutant of *P. nigra* L. in about the year 1700 on the Lombardy Plain in Italy. Houtzagers, however, considers that it may have been introduced into Italy earlier from Asia. Only male trees are found, and reproduction is always vegetative. Houtzagers has observed that the fastigiate varieties have a relatively short leafless period in the Netherlands. They do not tend to be semi-evergreen, however. In the south western Cape Province the young leaves of the semi-evergreen form begin to develop while most of the old leaves are still attached to the tree. They replace the old leaves as they fall. The deciduous form loses all its leaves early in the winter in May, and does not sprout again until the spring, in September or October.

The semi-evergreen form is possibly a mutant of *P. nigra* L. var. *italica* du Roi. The young shoots and petioles are not pubescent, and on leaf material alone it is indistinguishable from the deciduous Lombardy in summer. It is, however, more vigorous and the bark is consequently slightly fresher and greener in appearance. The clones introduced into South Africa have not yet flowered. It is at present unknown whether only male trees occur or not. Such a mutant might have arisen in Chili, from where it is said to have been introduced into the Argentine. If the variety is grown in an area with a cold winter it may not appear so strikingly different from the deciduous form. It may possibly merely develop somewhat earlier and defoliate somewhat later. This appears to be the case in the part of the Argentine from where material was introduced. Here it was observed that the mature leaves were killed by frost on the trees and then persisted for a while after death before dropping.

In the literature on poplars no reference is made to a semi-evergreen form of Lombardy poplar or of *P. nigra* L. (Henry, 1923; Houtzagers, 1937; Cansdale, 1938; Hubbard, 1926). Sim makes the following statement about *P. nigra*—the Black Poplar—however: "An excellent street tree, especially the evergreen form of it," but so far it has not been possible to trace the trees referred to by him (Sim, 1919). The case of the deciduous and semi-evergreen varieties of the Grey poplar (Hubbard, 1926) is analogous. The semi-evergreen Grey poplar has been given the separate varietal name of *Populus canescens* Sm. var. *Rossii* Hubbard, after Mr. C. R. Ross, formerly Conservator of Forests, who first noticed it in 1915. Such a step would also be justified in the case of the semi-evergreen Lombardy. No new name is suggested at this

stage, however, because a name may already have been given to it in South America from where the form was introduced. It is not known whether semi-evergreen varieties of other poplar species occur.

References

CANSDALE, G. S.: The Black Poplars. Imperial Forestry Institute, Oxford. 1938.

HENRY, A.: Botanical Description of Poplars in Forestry Commission Bulletin No. 5. His Majesty's Stationery Office, London. 1923.

HOUTZAGERS, G.: Het Geslacht Populus. H. Veenen en Zonen-Wageningen. 1937.

HUBBARD, C. S.: A Review of the Species of Populus Introduced into South Africa. *S.A. Journal of Science,* Vol. XXIII, pp. 340-365. 1926.

SCHIEMER, E. L.: The Growing of *Populus deltoides* in South Africa. *Journal of the S.A. For. Assoc.,* No. 5. 1940.

SIM, T. R.: Flowering Trees and Shrubs for use in South Africa. The Speciality Press of S.A., Ltd., Johannesburg and Cape Town. 1919.

A NOTE ON THE VEGETATIVE PROPAGATION OF *PINUS INSIGNIS*

By S. P. SHERRY

(Forest Research Officer, Pietermaritzburg.)

DURING 1939, while engaged in preparing a programme for genetic studies upon the exotic coniferous species used in afforestation in the Cape Province, the writer became acquainted with Field's work in New Zealand on the vegetative propagation of *Pinus insignis* Doug. (syn. *P. radiata* D. Don.) from branch slips (1).

In view of the great saving of time effected in the multiplication of selected stocks when these can be propagated vegetatively and the value of vegetative reproduction in genetic research, especially when dealing with promising but sexually sterile hybrids, it was decided that an attempt should be made to reproduce Field's results.

An initial small scale experiment was laid out at the Tokai nursery in August, 1939, using material from 2 and 6-year-old trees growing in the adjoining plantation. Branches of the first order from near the apex of the crown, and second order branchlets from the base of the crown were taken by pulling (Field's method) from 2-year-old and 6-year-old trees. In this method branchlets are removed from the stem or branch by a downward or backward pull which yields a cutting with a "heel" of older wood at the base. In addition, second order branchlets were cut with secateurs from the lower crown of 6-year-old trees. The cuttings ranged from 10 to 15 inches in length.

A few cuttings of each type were treated with Belvitan paste, a commercial hormone preparation for stimulating root growth, the remainder being untreated. All were planted in nursery beds, leaving a uniform length of about 5 inches above ground. The cuttings were given the same watering treatment as that used for pine transplants, the soil being thoroughly wetted at least once daily and twice in hot dry weather.

Callusing took place in most cases within three months of planting, and at seven months from planting, when the cuttings were lifted, some were found to have formed roots up to 30 inches in length. The excessive length of the cuttings made lifting, without causing root-damage, very difficult. Statistical analysis of the results of this trial was not possible owing to lack of replication, but there was no apparent difference in vigour or root development between the untreated cuttings and those treated with phytohormone, or between those collected by pulling and those cut with secateurs.

From experience gained in this trial it was decided that a further experiment should be designed to secure information on the following points:

1. The maximum age of parent tree from which cuttings giving a reasonably high percentage of strike could be obtained.

2. The type of branchlet best suited for cuttings.
3. The degree of watering required for maximum strike and survival.
4. The best season for setting cuttings, bearing in mind the need for producing plants of a suitable size for field planting at the correct season.

This second trial was laid out in the Tokai nursery in April, 1940, in the form of a randomized block with four replications. Cuttings were of seven types made from first order branchlets of 2-year-old trees, first and second order branchlets of 5-year-old trees, and first, second, third and fourth order branchlets of 8-year-old trees. Cuttings of each type were divided into three lots for different watering treatments consisting of a normal watering, as given to coniferous transplants, carried out daily, every third day and every sixth day. These treatments were to be repeated with subsequent plantings in June and August.

Following the methods of Jacobs (2), all cuttings were trimmed to a uniform length of 7 inches with a hatchet on a wooden block and were then planted to a uniform depth of 4 inches, spaced 2 inches apart in rows 9 inches apart. Individual treatments consisted of 40 cuttings.

The April planting was carried out according to plan, but, as a result of staff changes and reduction of personnel due to the war, it was found impossible to carry out further plantings and even the individual watering treatments were discontinued after July owing to the difficulty of supervision. The cuttings therefore received differential watering treatments for approximately two months and thereafter were all watered daily.

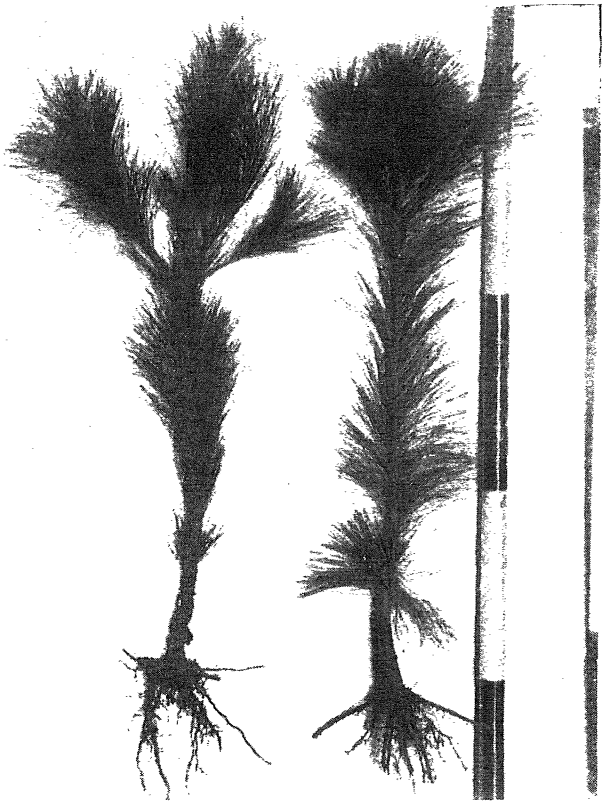
The accompanying table shows the mean heights of the different types of cuttings used and also the survival percentages at twelve months from planting in the nursery.

HEIGHTS AND PERCENTAGE SURVIVAL OF DIFFERENT TYPES OF CUTTINGS.

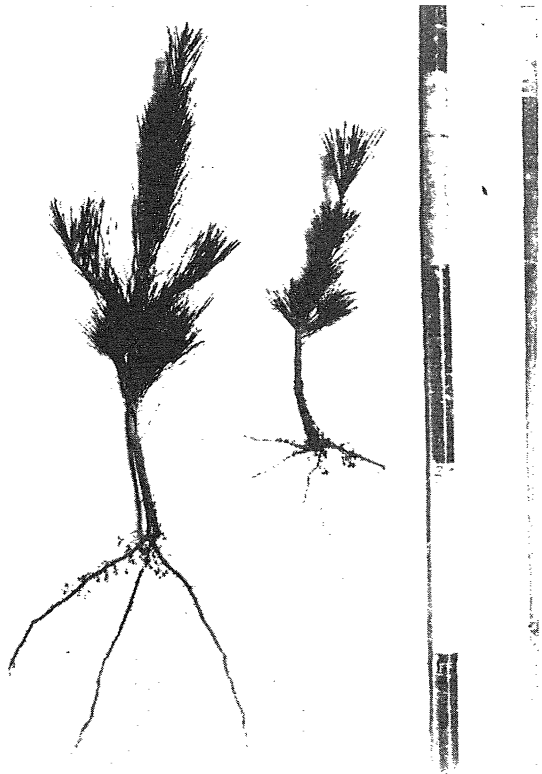
Age of parent tree. (Years.)	Branchlet Order No.	Mean height. (Inches.)	Percentage survival.
2	1	21·8	49·6
5	1	16·6	36·8
5	2	14·3	39·7
8	1	12·0	14·0
8	2	9·9	20·0
8	3	9·1	21·2
8	4	5·1	6·0
Standard error		0·85	4·06
Significant difference (P = .01)		3·1	14·8

Cuttings from 2-year-old trees were significantly faster growing than those of any other type, and there was a fairly regular, but not always significant, reduction in growth rate related directly to age of parent tree and branch order. As regards survival, the cuttings from 2 year and 5-year-old trees were significantly superior to all others. The short period of differential watering at the beginning of the trial was found to have had no significant effect.

In June, 1941, the surviving cuttings were lifted and set out in a field trial with ordinary commercial transplants of *P. insignis* as a control.



Cuttings from first order branchlet of 2-year-old *Pinus insignis* twelve months from planting.



Cuttings from first order branchlet of 8-year-old *Pinus insignis* twelve months from planting.

The accompanying photographs illustrate typical rooted cuttings from first order branchlets of 2 and 8-year-old trees at the time of lifting.

It was found that cuttings from trees up to 5 years of age were very large and called for considerable care and deep soil preparation in planting out. Future research in this field should, therefore, be directed towards producing smaller plants with vigorous root systems as a type more suitable for field planting on a commercial scale.

An inspection of this field trial ten months after planting revealed that the survival percentage of rooted cuttings from first order branchlets of 2, 5 and 8-year-old trees equalled that of the transplants, approximating 88 per cent., while second order branchlets of 5 and 8-year trees showed a survival of 78 per cent.

At this time, almost 50 per cent. of the cuttings from third and fourth order branchlets of 8-year-old trees were found to have died. It was noticed that most of the cuttings which had died had formed numerous new roots after planting out. The majority of these plants died probably during the prolonged dry period in February and March, during which period the total rainfall was only 0.4 inches.

These results indicate that vegetative propagation of this species in the Western Cape Province for field planting on a commercial scale should be quite practicable provided plants of a suitable size can be produced at the correct season. The cost of collecting and rasing cuttings should not greatly exceed that of raising seedling transplants and the technique could be readily mastered by intelligent native labour.

The thanks of the writer are due to the Forest Research Officer, Jonkershoek, who was responsible for carrying the trial to its conclusion and who furnished the data contained in this note.

Summary

Branch cuttings of *Pinus insignis* (syn. *P. radiata*) were successfully rooted in nursery beds at the Tokai nursery without the use of phytohormones. Cuttings from 2-year-old trees gave the best results in the nursery, but in subsequent field trials cuttings from first order branches of trees up to 8 years of age proved as hardy as seedling transplants. From the point of view of the perpetuation of desirable characters of selected stocks both for afforestation and in genetic studies, the results of these experiments are most encouraging.

References

1. Field, J. F.: Experimental Growing of Insignis pine from Slips. *N.Z Jour. For.* III, No. 4. 1934.
2. Jacobs, M. R.: The Vegetative Reproduction of Forest Trees. I. Experiments with Cuttings of *P. radiata* D. Don., Comm. For. Bur., Bull. 25. 1939.

A STUDY IN STEM DESIGN

By JOHN M. TURNBULL

(Timber Mechanics Officer, Forest Products Institute, Pretoria.)

THE chief functions of a tree stem are crown elevation and support, and conduction of nutriment. Wind pressure against the crown in large trees subjects the stem to enormous stresses, to counteract which with minimum expenditure in physiological activity and nutriment, stem form is so designed that their incidence at any point along the stem's length is constant (1). The effect on stem form of external stresses is manifest in various well-known ways. The long axis of the cross-section of eccentric stems is always oriented parallel with the direction of the prevailing wind. Isolated stems are always laterally reinforced in their lower parts beyond what obtains in stems of similar height growing inside a forest. Regions weakened by ingrown branches are reinforced by callous development. As will be shewn, moreover, such adaptations in form to provide against exposure in varying degree are themselves subject to modifications due to specific variations in inherent wood strength and in its manner of distribution, particularly transverse strength.

Spruce and pine were selected as material for a study which originated in an attempt to demonstrate the realisation of a preconceived theory regarding the logitudinal distribution of density in these two genera. Spruce species do not thrive in South Africa, and material from them for experimental purposes is accordingly difficult to procure. For purposes of this investigation, one stem only, of *Picea excelsa,* from Evelyn Valley Plantation, Eastern Cape Province, was available. The testing of some thirty sticks cut therefrom disclosed an average modulus of rupture at 12 per cent. moisture content of approximately 8,000 pounds per square inch. The average for *Pinus taeda* from Kluitjes Kraal Plantation, in the Division of Tulbagh, is approximately 12,000 pounds. Trees of these two species, equal in butt diamter and in total height, grown in the same or in similar environment, would be be unable to resist the same external stresses with equal effectiveness. The leverage provided by the pine's long stem would be too great for the weaker spruce. To render them equally effective, the height of the spruce would require curtailment in the ratio of the strengths of the species. The diameters applying in a pine stem at a constant interval would, in a spruce, therefore apply at an interval correspondingly reduced. Thus, as spruce material available had only two-thirds the inherent strength of *Pinus taeda,* provided strength in each species remains constant throughout the stem's length, or provided any longitudinal trend in this respect in both were similar, diameters applying to *Pinus taeda* at 13 foot intervals, in spruce would apply at intervals of 8·7 feet, with correspondingly accentuated taper. But the adaptation does not end here. As will be seen from Table I and the lower figure in the accompanying diagram, the longitudinal density gradient in the

TABLE I.

LONGITUDINAL DENSITY GRADIENT IN SPRUCE AND PINE.

Hght. in ft.	Values.							
	Spruce.		Pine.					
			1		2		3	
	S.G.*	R**	S.G.*	R**	S.G.*	R**	S.G.*	R**
0	·57	—	·58	—	·61	—	·66	—
10	·58	—	·51	88	·54	89	·58	88
20	·58	—	·45	77	·50	82	·50	76
30	·57	—	·44	76	·49	80	·48	73
40	·58	—	·43	74	·48	79	·45	68
50	·58	—	·43	74	·45	74	—	—

* True oven-dry specific gravity.
** Recession per cent. in specific gravity relative to butt values.

two genera is dissimilar. In a great number of pine species density decreases in ascent, whereas in spruce, almost up to the stem's tip, it remains constant. Now, as strength in coniferous woods is approximately proportional to a function of density, the strength gradient will also differ. For modulus of rupture the function is the exponent 1·25 (2 and 3), and as this exceeds unity, the deviation of the longitudinal modulus of rupture gradient for the stem wood of pine from the uniformity found in spruce will exceed the density deviation.

The adaptation discussed above in respect of inherent strength differences alone may be considered for the time being as applying to a stem of *Pinus taeda,* the wood of which is abnormally low in strength. That is, the profile resulting therefrom in principle is still not inappropriate to pine. It is shorter, but the strength at each amended height interval of 8·7 feet is proportionate to that at each original 13 foot interval in the actual pine. The form, in short, is that which a pine, unit strength of the wood of which is a third less than that of the Kluitjes Kraal trees, would assume had both the same butt diameter. As unit strength of the wood of this hypothetical pine, which may be designated "stem A," will, however, decrease in ascent, its stem at successive heights, in order to support the same stresses as spruce, must put on more wood than the latter at those respective heights; or, conversely, a spruce stem will support the same stresses as "stem A" with progressively diminishing cross-section. The spruce cross-section at any height will bear to the cross-section of "stem A" at the same height the same ratio as "stem A"'s density at the given height does to its own butt density, in each case raised to the power of 1·25, and as cross-sectional area is proportionate to the square of its diameter, this proportion may be given expression in the following equation:

$$\frac{d_1^2}{d^2} = \left(\frac{S}{S_b}\right)^{1.25}$$

$$\therefore d_1 = d\left(\frac{S}{S_b}\right)^{.625}$$

where d = diameter of "stem A" at any given height.
d_1 = converted value of d (i.e., of a spruce stem capable of supporting at a given height the same stresses as "stem A").
S = specific gravity of "stem A" across entire cross-section at the same height.
S_b = specific gravity of "stem A" at ground level.

Applying this equation to data derived from the first 78 feet of one of the Kluitjes Kraal pines, the converted diameters indicated in column 5 of Table II result. Actual diameters of the Evelyn Valley spruce, and

TABLE II.

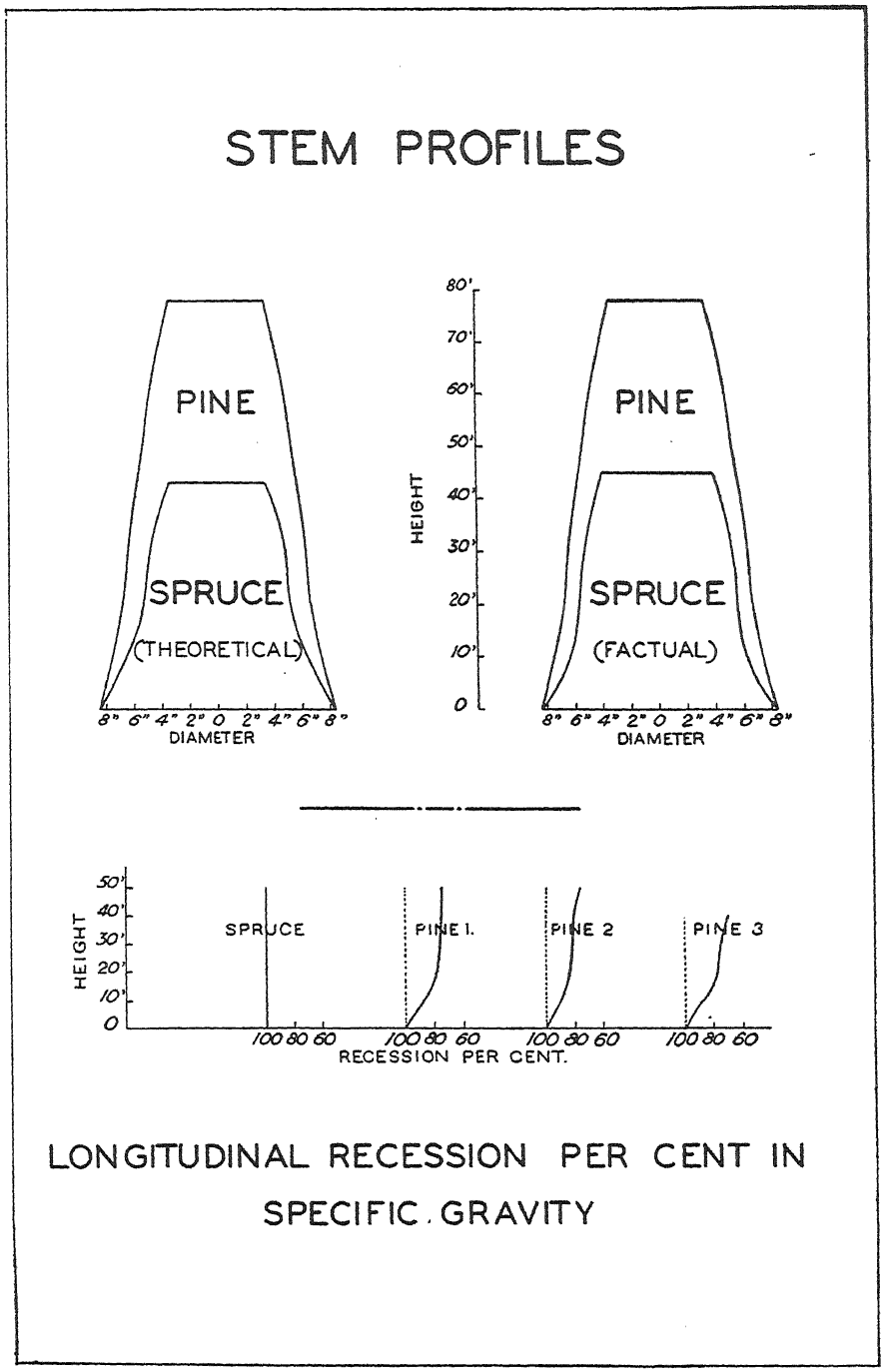
CONVERSION OF PINE DIAMETERS TO SPRUCE EQUIVALENTS IN INCHES.

Pine.			Spruce.				
			Theoretical.		Actual.		
Hght. in feet.	Diameter.	True oven-dry specific gravity.	Hght. in feet.*	Diameter.	Hght. in feet.	Diameter.	
						Actual.	+5·9"
0	16·6	·57	0	16·6	0	10·7	16·6
13	14·2	·51	9	13·3	13	6·0	11·9
26	12·8	·44	17	10·9	26	5·0	10·9
39	11·8	·44	26	10·0	39	3·0	8·9
52	10·5	·44	35	8·9	45	2·0	7·9
65	8·9	·38	43	6·9	—	—	—
78	6·8	·42	52	5·6	—	—	—

* Interval of 8·7' adjusted to nearest integer.

the same diameters to facilitate comparison in form, adjusted by a constant addition of 5·9 inches so as to retain a precisely similar profile with a butt enlarged to coincide with the butt diameter of the pine, are reflected in the final two columns. The actual and theoretical spruce profiles plotted from these data, each inscribed within the unmodified pine profile, will be seen, left and right, respectively, in the diagram. Other controlling factors are no doubt the effective area of the vertical plane of the crown exposed to impact by external forces, and environmental factors such as the effective force of the wind. There is also the varying proclivity in different species for response in reaction-wood development to stimuli of equal intensity; but where the incidence of these additional influences is equal, it might be contended that form and height are controlled by relative inherent strength modified by the manner of its distribution.

Although this investigation has been conducted on the basis of a single stem only of spruce, it is considered the statistical significance of that stem is enhanced by the fact that its density distribution confirms the only hypothesis on which the very close correlation existing between density and rate of growth in spruce can be explained (4). In 1937, moreover, the writer was shewn by Professor J. H. Priestly, of Leeds University, slides containing sections of a single growth ring taken at different heights in a spruce stem. These sections shewed no vertical trend in width of the summerwood tissue, whereas in pine it is the decrease in its width at successive heights that causes the decrease in



Stem profile and longitudinal density distribution of pine and spruce contrasted.

density (4). Finally, cambial reaction to foliar activity in spruce and pine has been shewn by physiologists to differ (5).

SUMMARY

On the basis of the relative inherent strength of the wood of pine and spruce, and the different manner of its distribution in the two genera, the profile of a theoretical spruce stem is plotted from data of specific gravity and diameter at successive heights in a pine stem, appropriately converted for the purpose. The resemblance of this profile to that of an actual spruce stem is held to support the principles on which the pine diameters were converted.

REFERENCES

1. BÜSGEN, M.: The Structure and Life of Forest Trees. Chapman & Hall, 1929. P.163.
2. MARKWARDT, L. J., and T. R. C. WILSON: Strength and Related Properties of Woods Grown in the United States. U.S. Dept. Agri. Tech. Bull. No. 479, 1935.
3. TURNBULL, JOHN M.: The Relationship between Modulus of Rupture and Weight in South African Grown Pine Timber. *Jnl. S.A. For. Assn.* No. 7, October, 1941.
4. ————: The Influence of Age on Summerwood Ratio in Pine Timber. *Jnl. S.A. For. Assn.* No. 1, October, 1938.
5. LANGMACK, S. P.: Influence of Climate on Diameter Growth of Pine. U.S. Forest Service (Division of Silvics) Translation No. 258.

MODERN METHODS OF WOOD CHARCOAL MANUFACTURE

By P. J. A. LOSEBY and C. C. van der MERWE

(of the Forest Products and Fuel Research Institutes, respectively.)

WOOD charcoal is a product of the combustion of wood in a restricted supply of air. If wood is burnt in a free atmosphere it is, as we all know, reduced to ash. This ash is essentially the mineral matter which was originally present in the wood in small quantities, the main body of the wood substance consisting of carbon, hydrogen and oxygen having been driven off as gas and vapour during the process of combustion. If the air, or oxygen, supply is restricted, most of the hydrogen but only part of the carbon in the wood is burnt away, the oxygen in the wood itself being used up in the process. What remains, therefore, is a product consisting almost entirely of carbon—or wood charcoal.

The special usefulness of charcoal for certain purposes was discovered many centuries ago and in the olden days its manufacture was regarded as a highly skilled craft. There is record of the practice of charcoal burning in the ancient Chinese and Egyptian civilisations, when this product was put to use in smelting metals. Its value as fuel was also appreciated in early times, especially where freedom from sparks and smoke was desirable. This use of charcoal persists to the present day and we find it utilised in bakeries, galleys on ships and trains, for forging metals and the like. Then the discovery of the method of hardening steel by introducing carbon into the metal gave an impetus to the charcoal burning industry, but with the evolution of steel alloys the demand gradually dwindled. It was at one time produced in fairly large quantities as a by-product of the wood distillation industry. In this process the main products are acetic acid and wood alcohol, but the subsequent discovery of other cheaper methods of manufacturing these substances led to another lean period. There appears, however, always to have been just sufficient demand to keep the charcoal industry alive. To-day perhaps one of the main uses of charcoal overseas is in the manufacture of carbon bisulphide, a chemical which is used in large quantities in the manufacture of artificial silk. Other uses to which charcoal is put are the manufacture of gun-powder and of rubber products, in filters and coolers, in the printing industry, as a constituent in animal and bird feeds, and as insulating material. Smaller quantities of special grades are used for medicinal purposes, in making sweets, as deodorants, in the arts, and as absorbent media in gas-masks.

The chief outlets for charcoal in this country are the manufacture of feeds for pigs, dogs and poultry, as fuel in bakeries and the like, in coolers and as fuel in stationary gas engines. The demand for all these purposes is fairly limited and, since the production of suitable grades requires little skill, the market is rarely under-supplied and the price realised leaves little to spare over production costs for any manufacturer

whose wood is anything more than a waste product. In the present emergency, however, there is the likelihood of a substantial demand developing for charcoal for use as a substitute fuel for vehicular internal combustion engines. Both in South Africa and overseas, research has been actively prosecuted during recent years to perfect the production of producer gas in portable generators and the operation of petrol vehicles on this substitute fuel. A special type of clean, graded, well-burnt charcoal will undoubtedly be required in large quantities as the producer gas vehicle becomes a familiar sight on the roads in this country. Whether this type of vehicle will remain with us after the war is problematical for, though possessing proven economic advantages, there is always likely to remain a certain amount of dirtiness and inconvenience in its operation.

Principles of Manufacture

When wood is heated in a container from which air is excluded, a stage is reached at about 300° C. where a reaction known as destructive distillation sets in, which brings about radical changes in the wood substance. This reaction is exothermic, developing its own heat and continuing, if the wood is dry, even after the external source of heat is removed. It is accompanied by the evolution of copious fumes containing gases, water vapour and the vapours of a number of other organic compounds, the formation of tar and the conversion of the wood substance into charcoal.

In the commoner methods of charcoal manufacture, in which the gases, vapours and tar are allowed to go to waste, the wood is placed in some form of kiln. Heat is not applied from an external source, but instead part of the wood itself is first burnt away to raise one part of the kiln to the temperature at which the exothermic reaction takes place. Once this reaction is initiated, it spreads eventually throughout the kiln until all the wood is carbonized. There is, however, always a certain loss of heat, which is spent in warming up the cold wood and evaporating moisture if the wood is wet. A certain amount is also lost by radiation from the walls of the kiln and, to make good wastage from all these sources, it is necessary to introduce a small amount of air into the kiln continuously in order to allow a small proportion of the wood and vapours to burn and generate additional heat.

Charcoal produced at the temperature at which the exothermic reaction takes places contains a very large proportion of tar, since high temperatures are required to drive off or break down this reaction product. The desirable tar content in charcoal used for almost all purposes, and more especially for generating producer gas, is very low and it is therefore necessary to raise the temperature of the kiln considerably in order to reduce the tar content to the required figure. This, again, can be achieved by admitting air to the kiln and burning a certain amount of the charcoal or other reaction products which quickly raises the temperature. It will be seen, therefore, that an essential for the operation of a charcoal kiln is the provision of air inlets which should be capable of being partially or completely closed as the conditions obtaining in the kiln dictate from time to time. For the major duration of carbonization, it is, however, usually sufficient in a well-designed kiln to set the air inlets in a fixed position so that the air supply is more or less constant.

Modern kilns incorporate the idea, which is taken from the old-fashioned earth-covered "meilers," of admitting air on what is called the counter-current principle. This is a fool-proof way of avoiding over-burning and consists in admitting air in the opposite direction to that in which carbonization proceeds. For instance, if a horizontal kiln is ignited at the western end so that carbonization takes place from west to east, then the air is admitted at the eastern end so that it flows from east to west. It can readily be understood how this procedure tends to keep the fire moving and prevents the ashing of the charcoal in any localised spot in the kiln, since the fire tends to advance towards the point where the air is introduced. The effect is especially noticeable in the operation of the kiln in the latter stages of the run.

The guiding principles of air regulation are, firstly, that a relatively large amount of air, that is, large air inlets, have the effect of producing high temperatures in the kiln, with the result that the charcoal yield is low in tar and volatile content. In the second place, the yield is often low since a relatively large amount of wood and charcoal is burnt to ash. Large air inlets, again, give a quick burn, but unless special care is taken in starting the fire evenly over the whole cross-section of the kiln, carbonization will tend to take place in channels, leaving a large amount of unburnt wood or underburnt charcoal (brands). On the other hand, small air inlets result in a slow burn and a high yield of charcoal containing a high percentage of tar and volatile matter.

The second essential feature of the charcoal kiln is the provision of outlets for the escape of the gases and vapours generated during carbonization. These usually take the form of chimneys which create a draught and ensure the proper circulation of air and fumes inside the kiln. Here again, it has been found that flues of certain sizes give optimum results under any given set of conditions. Too many or too large flues result in a tendency to overburn and, with unfavourable winds, certain of the flues may act as air inlets for part of the time. On the other hand, flues which are too small in total cross-section may unduly retard the rate of carbonization. As a general rule, the flues open at any particular time during carbonization should have a total cross-sectional area equal to approximately one-fiftieth of that of the kiln. Flues of this size are intended to provide for the carbonization of heavy moist wood in large sizes. Where dealing with dry, light wood, especially in small sizes, it is advisable to damp the flues down somewhat, more particularly in the latter part of the run and, when any section of the kiln appears to be completely carbonized, the flues nearest that section may be completely blanked off. Increasing the length of flues has the same effect as increasing the size of air inlets.

The principle employed in arranging the position of exhaust flues is what is termed reversed draught. This involves the leading back of the hot gases and vapours over the uncarbonized wood in advance of the zone of carbonization. To grasp this principle properly, let us again consider a horizontal kiln which is ignited at the western end and in which carbonization proceeds from west to east. In this case the flues are arranged so that those which are open are always to the east of the zone of carbonization and the fumes are therefore always passing over unburnt wood and heating it up before they exhaust to the atmosphere. This principle is one of heat economy which, in addition

to heating the wood before it starts carbonizing, also aids in drying it. The result is that a quicker burn and a higher yield are obtained.

In designing a kiln, the third essential is that it must have air-tight walls, otherwise some difficulty will be experienced in stopping the reaction and preventing the charcoal from burning once carbonization is completed. The metal kiln is undoubtedly the best from this point of view, then a pit or sunken kiln, and least efficient, unless very carefully constructed, is the brick kiln above ground level. In the design of a kiln, however, an important essential is to provide for a quick cooling, since it is often the case that cooling the kiln occupies as long or even longer than actual carbonization. It is for this reason that sunken kilns, especially of large size, possess distinct disadvantages.

Selection and Preparation of Wood

Though for many purposes high density is not essential, producer charcoal should be as heavy as possible. To achieve this end, it is important that dense species of hardwoods should be selected for carbonization. It has been shown that to obtain the best results, the wood to be carbonized should be as dry as possible, and in building up stocks of wood the first operation after felling is to remove the bark. Bark is most easily removed when the wood is quite green and, apart from this advantage, early removal of the bark is conducive to quick drying of the timber. Another important reason for removing bark is that it contains a large amount of mineral matter which gives the resultant charcoal a high ash content, which is undesirable.

In order to ensure the quickest possible drying of the wood, it should be stacked openly in crib-work fashion, so that air may circulate freely about all the pieces in the stack. In this way, too, there is little chance of decay setting in. Decayed wood yields a very poor quality of charcoal.

The wood requires to be cross-cut into lengths to suit the dimensions of the kiln and, in any case, crooked pieces must be reduced in length so that the kiln charge may be packed as tightly as possible. If a wide range of sizes is present, the wood should be sorted for size so that the total variation in diameter of the pieces used in any one charge does not exceed three inches; for instance, billets from two to five inches in diameter may be used in one run and those from five to eight inches in diameter in the next. It is recommended that pieces over eight inches in diameter should be split before charging, but it is unfortunately a very difficult operation in the case of a large number of species. The largest pieces should be placed near the top of a horizontal kiln or near the bottom in the case of a vertical kiln.

It is important that the charge should consist of only one species of wood and that all the wood should be of approximately even moisture content. If this precaution is not observed, parts of the kiln may be overburnt while in others only partial carbonization may take place.

Provided the recommendations made in the foregoing sections are followed, it is possible to produce charcoal from almost any species of wood grown in this country. The properties of the wood have, however, an important bearing on the quality of the charcoal produced and for this reason it is desirable to exercise some sort of selection of the species used in its manufacture. A soft charcoal which crumbles easily is to be avoided in almost all circumstances, which rules out species of wood which are low in density. For the manufacture of producer charcoal, the densest wood available should be selected and, in order to arrive at a

low ash content, it is necessary to use species from which the bark may readily be removed.

Wattle wood (*Acacia mollissima* and allied species) is probably the wood *par excellence* for the manufacture of charcoal for all purposes. It is available in large quantities at relatively low prices with the bark, which has an independent market, already stripped off. It is a fairly dense wood which carbonizes readily, giving uniform results and when dry splits very easily.

All species of *Eucalyptus* of medium and high density which have been experimented with have given good results provided the wood is correctly prepared. If large sizes are used, it is advisable to ensure that the wood is thoroughly dry before carbonization.

Saligna gum (*Eucalyptus saligna*) presents certain difficulties in carbonization and, on account of a strong propensity of the charcoal to burn to ash, it is recommended that only wood over three inches in diameter be employed. This species has the disadvantage of producing a dusty charcoal of low density.

Pine species grown in this country are generally not recommended where a dense charcoal is required. It is probable, however, that with careful control, satisfactory charcoal will be obtained from such species as *Pinus pinaster, P. canariensis, P. halepensis,* and *P. pinea.*

Exotic scrub wattles such as Rooikrans (*Acacia cyclopis*) and Port Jackson Willow (*A. cyanophylla*) have been used to some extent and the product should prove suitable for all uses provided that the bark is removed before carbonization. Indigenous scrub acacias such as *Acacia karroo* would probably yield a similar product. The difficulty in obtaining satisfactory charcoal from certain of the denser local scrub timbers, such as Mopani (*Copaifera mopani*) and Wild Olive (*Olea verrucosa*), lies in the removal of the bark, which, in the case of the former, is economically impossible.

The criteria by which the suitability of other woods for charcoal manufacture can to a large extent be determined are availability, cost, density (above average), and ease of barking.

General Operation of Kilns

Details of the construction and operation of various types of kiln are given in a later section, but a short description here of the general procedure will help towards a better understanding of the practical technique. The kiln is ignited at a suitable point where a bundle of kindling has been placed in it. It is a good plan to place a number of brands (pieces of under-burnt charcoal) over the cross-section of the kiln at the point of ignition and a little paraffin sprinkled over these will be of assistance in getting a hot fire started evenly, especially when burning dense, moist or large-sized pieces of wood. During the period of ignition free access of air and free escape of smoke is allowed until it is certain that a hot fire is firmly established, and when working with timber which is rather moist a few extra minutes given to the lighting of the kiln will be well repaid by obtaining a quicker and more even burn. Little difficulty is experienced in lighting kilns containing small sized, dry timber, and these may be successfully ignited in fifteen minutes, whereas four or five times this period is often not too long for a more refractory charge.

After complete ignition, follows the warming-up period, in which air is somewhat restricted, but free escape of smoke allowed. It is often impossible to reverse the draught directly after ignition without putting out the fire or causing an explosion, and for the warming-up period, therefore, the smoke is usually only led back part of the way to the eventual position of the exhaust flues. During this period, the zone of carbonization is spread as thoroughly as possible over the full cross-section of the kiln and the kiln is generally heated up to establish the correct circulation of smoke and air within it. The period of warming-up varies very considerably according to the size and type of kiln, being longest in vertical kilns where rather wet wood is being carbonized. After warming-up, the draught is completely reversed to the exhaust flues in their final position. At the same time the air inlets are set according to the nature of the wood in the kiln and the condition of the wind, and it may be necessary to make adjustments from time to time until carbonization has advanced through the whole charge. The next operation, when the burn is complete, is closing down, which entails the complete sealing up of air inlets and flue openings so that the fire may go out and the charcoal mass cool down. In this, one is guided by the colour of the smoke, the temperature at the base of the kiln or visual inspection through the air openings. The smoke over the main period of carbonization is white in colour and issues copiously. Towards the end of the run it becomes much thinner and assumes a bluish tinge. In order to ensure that a charcoal of low tar content is produced, one must be sure that the base of the kiln has attained a high temperature before closing down.

Before the charcoal can be removed, the kiln must be allowed to cool down to a temperature at which it can be handled and at which there is no danger of its catching fire. As a precaution, charcoal should never be bagged and stored straight from the kiln and bags containing meal or oily substances should not be used for the purpose. The period required for cooling is variable, depending upon the size and construction of the kiln. Portable metal kilns cool quickly and charcoal can always be removed with safety after 15 hours of cooling. With large brick kilns or pits, the cooling period may extend over several days and even then it may be necessary to have water handy in case the charcoal takes fire. As a general rule, it is for this reason advisable to keep the cross-sectional area of the kiln reasonably small.

Yields

The yield of charcoal obtained by burning wood in kilns is usually in the vicinity of 20 to 25 per cent. by weight of the original wood, calculated on wood containing 20 per cent. moisture. Dry wood of low density and in small pieces gives a considerably lower yield than this unless carbonization is carefully controlled throughout. A yield of over 25 per cent. should be suspected of having a very high tar content. The yield by volume is about 50 per cent. These figures refer to the gross yield of charcoal of all sizes. If any crushing and screening has to be performed, a quarter or more of the charcoal may be lost as dust or fines. In almost every burn, a certain quantity of brands is produced, but with experience these can be reduced to a minimum. Brands can be easily recognised by their heaviness, or reddish colour in comparison

with the properly burnt charcoal, and they should always be separated out. They may conveniently be used for starting up the next kiln.

KILNS

Brick Kilns.

Brick kilns may be made in various sizes to suit the requirements of the manufacturer. Two sizes of horizontal kilns which have been found to give satisfactory results are described, the smaller producing about 500 lbs. of charcoal per burn, and the larger with a yield of approximately 1,750 lbs.

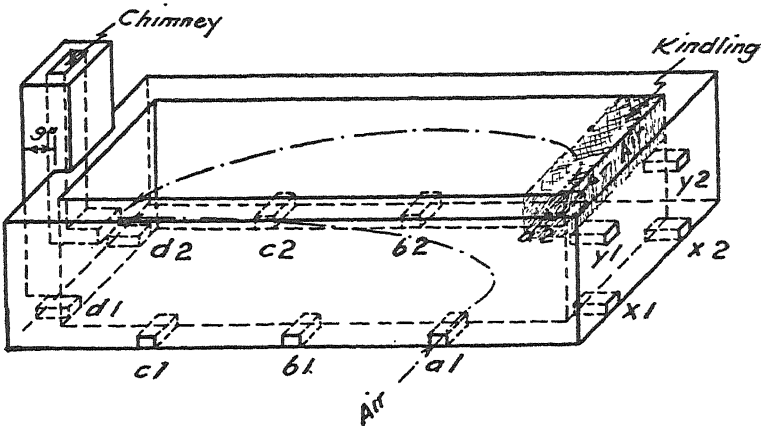


FIG. 1.—Air circulation in brick kiln.

The principle employed in this type is illustrated in Figure 1. Air is admitted through inlets a_1 and a_2 and the hot vapours pass through the charge before escaping through the chimney. At the same time a considerable amount of tar condenses on the wood and eventually drips down on to the bottom layers of wood. While advancing along the floor of the kiln, the fire burns all this condensed tar and this is thought to produce the high temperature required for reducing the volatile content of the charcoal. In this particular design of kiln, if a fast rate of carbonization is established at the commencement of the burn, practically no ash will be produced.

It is here unnecessary to judge the completion of the carbonization by colour of the smoke. An air inlet must be closed only when the wood opposite the inlet is completely carbonized. This is indicated when large glowing lumps of charcoal fall into the furrow connecting the inlet with the inside of the kiln. Control of the carbonization according to this method produces charcoal containing a very low percentage of tar and under-burnt wood.

The Small Horizontal Brick Kiln.

The design of this kiln is shown in Folder No. 1. The walls are erected over a concrete foundation 6 inches deep and 12 to 15 inches wide.

The brick walls (except the two upper courses) are built with ouklip or loamy clay mortar. They are nine inches thick and can be built of a fairly low grade brick. The spaces between the bricks must be well packed with mortar in order to avoid air leaks, and it is advisable to break joint as far as possible. Cement is used as mortar in the two upper layers to reduce the likelihood of damage when loading and unloading. The floor is levelled and the bricks placed as shown in the folder and grouted in with clay mortar.

The bottom layer of the wood should consist of poles of not more than four inches in diameter, which should be packed at right angles to the length of the kiln. The remaining wood is packed lengthwise. It is advisable to pack the bottom two or three layers, and also along the sides of the kiln with the thinnest wood available. An ideally packed charge will thus be as illustrated in Figure 2.

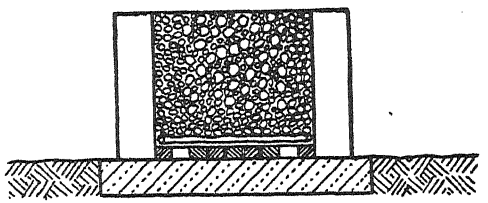


FIG. 2.—Distribution of charge in horizontal brick kiln.

On top of the charge and at the end remote from the chimney, a space one foot wide and eight inches deep should be filled with thin twigs together with split wood and partially burnt wood, from previous burns, for kindling.

In operation, the first air inlet on each side nearest to the firing end is opened, and the rest closed by placing a brick in the opening and covering with earth. The chimney is opened and the kindling lit. Care must be taken to obtain an even, strong fire across the width of the kiln in the kindling zone. The kiln is then covered with corrugated iron sheets and sealed with earth.

Air is progressively supplied to the fire through succeeding air inlets, as it travels from one end of the kiln to the other. This is achieved by closing the air inlets as the fire reaches them and opening the next adjacent pair of inlets. An air inlet is closed only when the wood opposite the inlet is completely carbonized as can be determined by visual examination.

Air inlets x_1 and x_2 are employed only after the fire has reached inlet a_1 or a_2 to ascertain whether the wood below the ignition zone is completely carbonized. If it is not, they are allowed to remain open until it can be seen that carbonization has been effected.

The whole burning operation takes from 15 to 20 hours, and the kiln is then carefully sealed. The kiln is allowed to cool for about 20 hours, during which period access of air must be prevented by sealing all cracks and leaks.

Large Horizontal Brick Kiln.

Details of the construction of this kiln are shown in Folder No. 2.

It is erected, packed and operated in the same manner as the small rick kiln, except that in the large kiln two air holes on each side are pen at the same time.

With this kiln the burning operation takes from 20 to 25 hours, and ooling about 20 hours.

The Conical Brick Kiln.

This kiln is described by kind permission of Mr. Hunt Holley, of Umkabela, Natal, who has a number of the type in operation and who has been producing charcoal for forty years. This is a kiln of very large capacity, taking up to thirty tons of wood and yielding about seven tons of charcoal per burn. Carbonization of the charge takes place in the extremely short time of 12 to 24 hours, but, on account of the large cross-sectional area of the base of the kiln, cooling is so slow that the kiln can be run only three or four times per month.

The design of the kiln is illustrated in Figure 3. A kiln with 14-inch

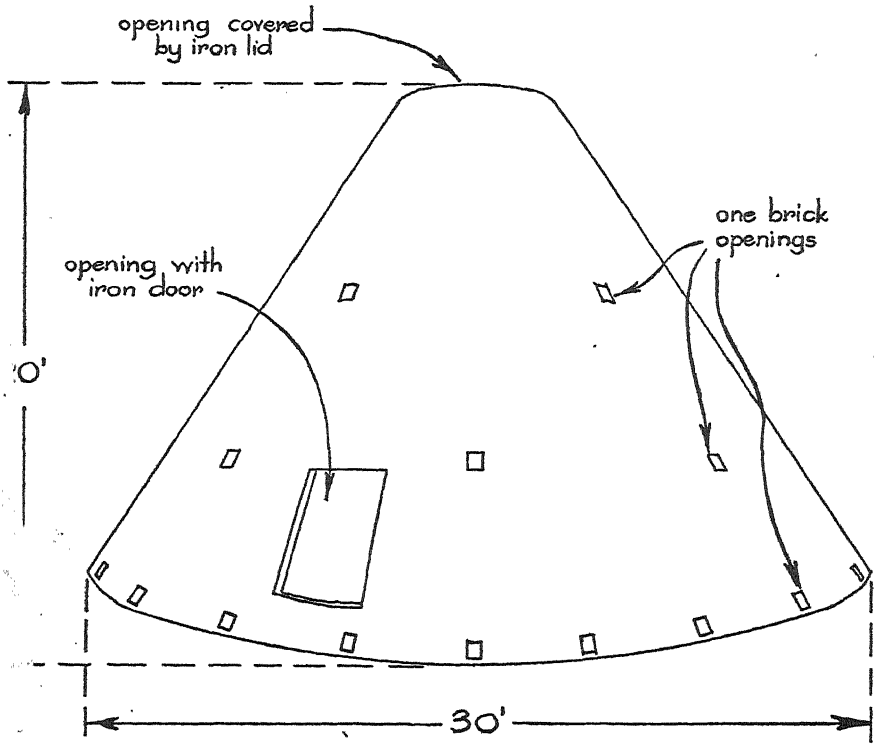


FIG. 3.—Conical brick kiln.

walls was found to have a life of about seven years and it is thought that the provision of 18-inch walls will increase the life very considerably. A certain amount of skill is required in building the walls, which are erected on a tilted foundation to give them the correct batter. The top of the kiln is re-inforced with a steel ring with projections which are let into the brickwork. An iron lid is provided and also an iron door for charging and discharging.

The kiln is packed with wood up to 15 feet in length through the door, charging of the uppermost part being completed through the top opening. The charge is ignited at the top and as soon as the fire is strongly alight, the lid is dropped into position. The smoke now issues from the top row of openings in the wall, air being drawn in through the lower rows of openings. As soon as it is apparent from the colour of the smoke that carbonization has proceeded as far as the upper openings, these are closed down with the result that the middle row of openings now function as smoke outlets. These are closed as soon as the smoke shows indications of turning blue and the burn is run to completion with only the apertures round the base of the kiln open. These are closed one by one as the smoke becomes blue, until eventually all of them are sealed. Any leaks which then become evident are carefully sealed and the kiln is left for several days to cool down.

Metal Kilns

Efficiently designed metal kilns possess certain distinct advantages over brick kilns, the chief of which are quick carbonization and quick cooling, portability and freedom from leaks. On the other hand, the larger metal kilns are expensive in first cost and the wood to be charged requires to be cross-cut into relatively short lengths. Two types are described, which have been designed to cater for the small and large-scale charcoal manufacturer.

The Oil Drum Kiln.

This has been designed for the person who wishes to produce charcoal in small quantities for his own use. The yield from a 44-gallon drum varies from $\frac{1}{2}$ to $\frac{3}{4}$ bag per run, and it is possible to carbonize two charges per day.

The drum is placed in a position so that the small plug-hole A_2 is vertically above the bigger plug-hole A_1, as shown in Figure 4.

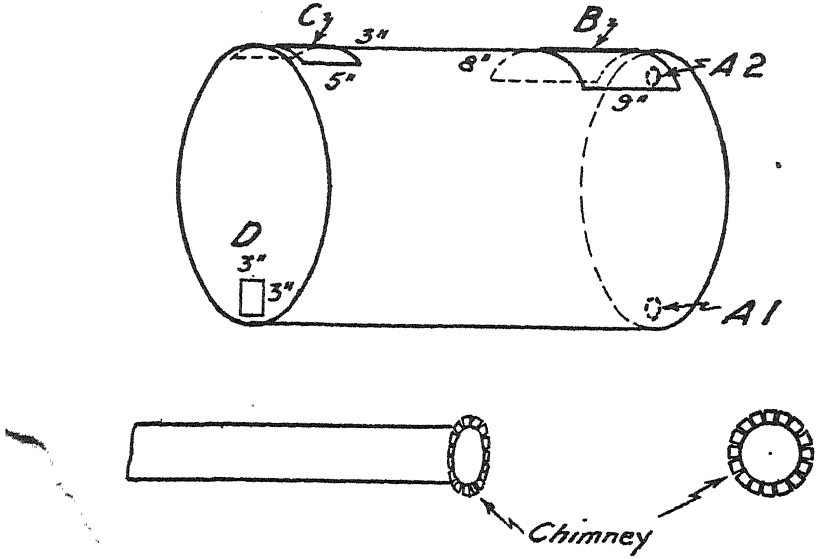


FIG. 4.—Oil drum kiln.

Rectangular holes B and C (9″ x 8″ and 5″ x 3″ respectively) are cut in the drum and a hole 3″ x 3″ is made as indicated at D.

An ordinary stove pipe of 3′ length and 6″ diameter is used as a chimney.

A reversed draught effect is obtained by firing at A_1 and introducing air through D, the smoke escaping through C.

Wood having a diameter of 5″ maximum, and varying not more than 2″ must be used. The wood is cut into 8″ lengths and should be packed fairly tightly to prevent channeling of air during carbonization. It is charged through opening B and the drum intermittently rocked. Kindling is packed over plug-hole A_1.

Special care must be taken not to block the air inlet D and the smoke outlet C, and it is important that the wood across the drum at the firing end be packed very evenly to prevent uneven burning after the kindling is lit.

A strong fire is allowed to develop before holes A_1, A_2 and B are closed. The chimney is placed in position over hole C and sealed on to the drum with clay. As soon as all the wood opposite the air inlet is completely carbonized the chimney is removed and all the openings closed and sealed. The whole burning operation takes from 2 to 4 hours, and 3 hours cooling is sufficient.

The Large Portable Steel Kiln.

A number of designs of portable steel kilns have been patented from time to time and with most of them it is possible to turn out good yields of charcoal of a grade suitable for use in producer gas generators. The kiln illustrated in Folder No. 3 is designed to reduce construction costs to a minimum and achieve maximum simplicity in operation. It will produce six tons of charcoal per month and costs about £45-£50 to make. It is built in two cylindrical sections, which fit one above the other, and is provided with a slightly convex cover. The lower section is made of $\frac{1}{8}$″ mild steel plate and the upper section and lid of $\frac{1}{16}$″ plate. A removable inner lining ring fits within the lower section to protect it from the high temperatures developed during carbonization. Side flues emanating from the base of the kiln are provided, while air inlet pipes are fitted radially round the floor.

To operate the kiln, the lower section is set up on a suitable site close to the supply of wood, sheltered from winds if possible. The air inlet pipes are inserted and the inner lining plates placed in position. The wood, which has previously been cross-cut into 15-inch lengths, is then thrown into the kiln without any attempt at packing in any particular arrangement. Care should, however, be taken not to block the air inlets. When the wood reaches the level of the top of the bottom section, the upper section is placed in position. The channel round the upper rim of the lower section is filled with sand or ash and four short pieces of $\frac{1}{2}$-inch flat iron are then laid across the channel, so that when the upper section is placed in position a $\frac{1}{2}$-inch gap is left between the two sections. Similarly, when the whole kiln is full of wood, the upper channel is filled with sand or ash and four more pieces of $\frac{1}{2}$-inch iron are placed across the channel so that a $\frac{1}{2}$-inch gap is formed between the upper section and lid. Before closing the kiln with the lid, a hole is made in the wood centrally on top of the charge by removing a number

of the billets. The opening should be about two feet deep and two feet in diameter and is packed with kindling and brands with a few small billets of wood over the top to bring it up to the level of the rest of the charge.

The charge is lit by means of a burning stick, previously soaked in paraffin, which is pushed down through the central opening in the lid into the kindling. This will then burn up strongly and ignite the surrounding billets which should be allowed to burn up and develop considerable heat. After the ignition period, a cover is placed over the central lid opening which has the effect of damping the fire and forces out copious white fumes through the gap between lid and upper section. The charge is allowed to burn in this fashion for a period of from one to two hours, depending on the dryness of the wood. The iron bars are then pulled out and the lid worked down so that it beds in the sand in the upper channel, and the warming-up period is completed by allowing the smoke to escape from the ½-inch opening round the middle of the kiln for another one or two hours. In the meantime, the side flues are placed in position in their flue boxes and when the central gap is closed by removing the iron bars, the smoke should, after a few minutes, issue strongly through all these flues. If the reaction shows signs of dying, the central gap is again opened for perhaps an hour to revive carbonization. The kiln should burn without attention until the reaction is nearly complete, when it will be found from the colour of the smoke or the temperature round the base of the kiln that one section may be more advanced than others. As soon as the smoke turns a thin blue, each flue is in turn removed and the air inlets on each side of it damped down by half or a greater proportion of their cross-sectional area by means of loose plates provided for the purpose. When the last flue has been removed, all air inlets and flue box openings are carefully sealed over with sand and the kiln left overnight to cool. To remove the charge, the lid and upper sections are removed and the charcoal dug out with ballast forks.

Charcoal Pits.

Charcoal pits are not recommended where a clean product is aimed at, such as is required for producer gas generation, on account of contamination with soil, and these pits are also liable to become flooded in rainy weather. For small scale operation, however, where a farmer manufactures charcoal for his own consumption and can give close

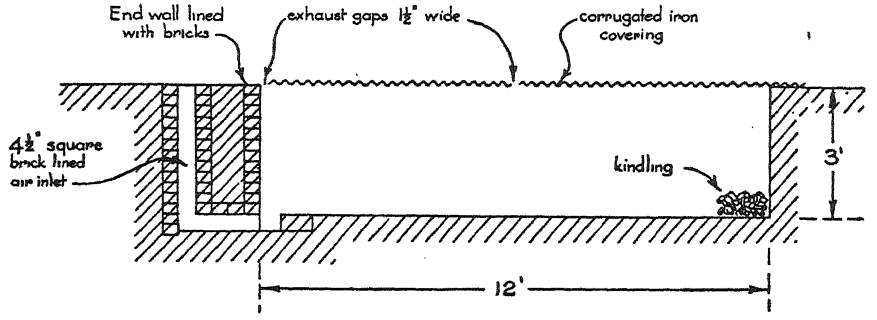


FIG. 5.—Small charcoal pit.

supervision to the work, a small pit 12′ long, 4′ wide and 3′ deep, as illustrated in Figure 5, will give fairly satisfactory results.

If the wood is straight it may be used in fairly long lengths, otherwise it should be cut to pieces about 3′ long to facilitate tight packing of the charge. It is stacked lengthwise in the pit with a small space packed with kindling, as shown in the illustration. The kindling is ignited and the fire is allowed to burn strongly for 10 to 15 minutes, after which period sheets of corrugated iron are laid across the top of the pit as far as the middle. The half-covered pit is allowed to burn for a further 20 to 30 minutes and more sheets of iron are then placed across the top, leaving two 1½″ gaps, one at the centre and one at the end remote from the ignition point. After about six hours, the central gap is closed and carbonization is allowed to run to conclusion with smoke issuing from the end gap only. When the smoke becomes blue and glowing embers can be seen through the gap, all openings are closed and thoroughly sealed over with sand.

If the charge is lighted at 10 a.m., the middle gap may be closed at 4 p.m. or 5 p.m. and the burn then allowed to continue overnight. Carbonization will be complete early next morning and a further 24 hours will be required for cooling, making a two-day cycle in all.

If brands are found at the bottom or along the sides of the pit, they should be left in approximately the same position in the pit for the next charge.

Crushing and Grading

Charcoal often has to be graded to size to suit the requirements of the market and for this purpose crushing and screening equipment is required. For small scale operations, the material may be crushed by means of a form of pestle or hand stamp on a concrete or wooden floor. A piece of ⅜″ steel plate about 10″ square and fitted with a 5-foot handle has been found to work well. Where a large output is handled, a mechanical crusher may give better results, but a really satisfactory design of machine is not easily procurable. Certain manufacturers make use of the hammer mill, which, however, produces a high percentage of fines and dust.

For grading to size, a swinging screen similar to the diamond digger's "dummy" may be employed, and where the particle size is required to be between two limits, a double grader consisting of the two screens of requisite mesh one above the other may be used.

Summary

Describing the uses, principles of manufacture, and the crushing and grading of charcoal, with detailed descriptions of various new types and sizes of kilns and pits, and the selection and preparation of wood used in its manufacture.

LUMBER MILLERS AND SHOOK MANUFACTURERS GET TOGETHER

By PHIL WHITE

(Secretary, The South African Lumber Millers' and Shooks Manufacturers' Association.)

WHEN the South African Government 20 years ago decided on a policy of extensive afforestation, they could hardly have foreseen how soon it would play a vital part in the economy of this country.

South Africa is an extensive user of wooden containers, but until six years ago practically all its requirements were imported from overseas. In the meantime the disposal of thinnings from the plantations laid down some 20 years ago were providing the Forest Department with a difficult problem, and it was not until about 1935 that a few local sawmillers were induced to make a serious effort to utilise them on a commercial scale. They encountered innumerable difficulties and it can be said that a sawmilling industry as such scarcely existed prior to 1939. The few private sawmillers that did devote themselves to the utilization of the thinnings of the Department's forests received little encouragement from any quarter. Fortunately, in order to show what could be done, the Department itself had about this time erected a number of pilot plants, which, together with the few private plants then existent and those subsequently installed, have been kept continually extended in a remarkably successful endeavour to meet the requirements of the Department of Defence.

When war was declared, however, and it was seen that overseas supplies were likely to be cut off, many of those who had previously doubted the possibilities of South African grown timber entered into a desperate struggle to obtain home-grown supplies, and commenced sawmilling. Mills sprang up throughout the country and rapid expansion in all directions took place. There was no contact between millers, however, and those few who had been in the industry from the commencement were alarmed, believing that lack of cohesion, both in the buying and marketing of the various products, would harm the industry when normal times returned.

Mr. S. Moshal, Managing Director of the Acme Box Factory (Pty.), Ltd., took the lead in remedying this state of affairs and, after consultation with the Director of Forestry, who enthusiastically supported the idea, convened a meeting of sawmillers in Johannesburg on the 15th July, 1941. The first meeting was attended by the representatives of 19 firms, Mr. A. J. O'Connor representing the Director of Forestry. It was unanimously agreed that an Association to be known as "The South African Lumber Millers' and Shook Manufacturers' Association" be formed. A constitution was framed and adopted, membership of the Association being confined to lumber millers and manufacturers of

shooks and others mainly concerned in the processing of South African grown coniferous timber.

It was also decided to elect an Executive Committee consisting of not more than seven members to conduct the affairs of the Association and to meet at least once in every three months. The first Executive Committee of the Association was elected as follows:

Chairman:	S. MOSHAL, Acme Box Factory (Pty.), Ltd.
Vice-Chairman:	A. KURLAND, Boxes and Shooks (Pty.), Ltd.
Hon. Treasurer:	A. W. SUMMERS.
Members:	S. SUSKIN, Lumber and Box Co.
	ROBERT C. LEYLAND, Sawmill Owner.
	E. A. BETTON, Broedersdraai Sawmills (E. A. Betton & Sons).
Alternates:	T. C. BOOTH, Jessievale Saw Mills Co.
	P. J. SMOLLAN, Boxes and Shooks (Pty.), Ltd.
	C. STERNBERG, Acme Box Factory (Pty.), Ltd.
Secretary:	P. WHITE, General Secretary, S.A. Federated Chamber of Industries (Inc.).

The objects of the Association as set out in its Constitution are:

(a) To organise the orderly utilization and distribution of the products of South African coniferous forests.

(b) To create a centre or means for the members of the Association to exchange views, statistics, and any other available information with a view to the better working of object (a) above.

(c) To act as the mouthpiece of the members when dealing with Government Departments, National Institutions or the public as a whole.

(d) To take such steps as may be necessary from time to time to protect the interests of its members against unfair competition from whatever source same may emanate.

(e) To promote and protect the interests of the employers in the lumber milling and shook manufacturing industries in the Union of South Africa.

(f) To determine and regulate in such manner as may from time to time prove necessary, rates of pay, working conditions and other measures affecting employees engaged in these industries, and to encourage and effect the settlement of disputes by enquiry, conciliation and arbitration.

(g) To co-operate with a trade union or trade unions and to represent the Association on any industrial council or conciliation board which may be established to deal with matters which affect members.

(h) Whenever so required, to represent its members in all matters arising under the Industrial Conciliation Act 1937, the Wage Act 1937, or under any other laws for the regulation of disputes between employers and employees, and of wages and conditions of work in the said industries.

(i) To act on behalf of its members when necessary in connection with matters governed by the provisions of the Apprenticeship Act 1922, or any amendments thereof.

(j) Generally to take such steps as may be necessary to place the industry on a sound footing economically and to maintain it as such, and generally to act on behalf of its members in any direction in which their interests may be affected, and to do such things, and carry out all such undertakings, as may be necessary or incidental to such objects.

Names were obtained from the Forestry Department and every sawmiller throughout the country was circularised. The response in membership has been excellent, and up to the present 27 firms have been enrolled as members, and others are likely to join in the near future.

One of the first acts of the Committee was to find out the actual part played by the sawmilling industry in the general economy of the country, and 53 replies to a questionnaire addressed to members and non-member firms yielded the following information regarding employment in the industry at the present time:

Europeans:	Male	463
	Females	24
Natives		4,469
Coloureds		721
Indians		193

A total of 4,870, with a wage bill of approximately £300,000 per annum, exclusive of State employees.

These figures alone—current output and amount of capital invested are not at present known—establish this rapidly-expanding industry as one of vital importance to the country. The aim of the Association is accordingly to direct its development and safeguard its future, and in this its pioneers confidently count on the co-operation of the Forest Department, which, as the largest grower of timber in the Union, is naturally interested in the development of a healthy sawmilling industry.

At the first annual general meeting of the Association, held in Johannesburg on the 30th October, the Chairman, Mr. S. Moshal, announced that machinery had been set up for the purpose of instituting a general survey of the activities of the industry as a whole. A close watch would be maintained on the latest developments in wood uses, including the vast possibilities of wood-derived plastics, and to this end and in order to further propaganda appropriate to the Association's objects and the country's interests, a sum of £1,200 had already been subscribed by members towards the establishment of a research bureau.

The Chairman drew attention to a number of disabilities with which the industry still had to contend, instancing the system of short term contracts under which at present softwood logs from the main source of supply alone could be obtained, and suggested that in view of the perpetuity basis of the Government's afforestation and regeneration programme contractors might reasonably expect a 15 to 20 year tenure as against the prevailing five year term. The relationship existing between the Association as representing the largest portion of the manufacturing and distributing interests, and the Government as chief producer of the raw material of the industry, moreover, was such as to justify some claim to consideration of representations made by the former in connection with the shaping of a national forest policy. Certain proposals regarding price control had as a matter of fact been placed by the Association

before the Director of Forestry, and it was felt that they were receiving sympathetic consideration.

Some apprehension had arisen from rumours to the effect that Government policy was developing along lines which might possibly result in direct competition by the State with private enterprise, with consequent discouragement of investment of capital in the industry. Close and friendly co-operation between Government and the industry should, however, ensure the fullest realization of the mutual interests of both parties compatible with the national welfare.

PUBLICATIONS RECEIVED

Receipt of the following publications is acknowledged with thanks:

ANNUAL REPORT OF THE FORESTRY DEPARTMENT, Nyasaland Protectorate for the year ended 31st December, 1941.

AUSTRALIAN FORESTRY. Vol. VI, No. 2, 1942.

CANADIAN RESOURCES BULLETIN. No. 223, July, 1941.
224
225
226, August, 1941
227
234, September, 1941.
238, October, 1941.

EMPIRE FORESTRY JOURNAL. Vol. 21, No. 1, 1942.

FIFTEEN YEARS' MARKETING RESEARCH IN SOUTH AFRICAN TIMBERS

By NILS B. ECKBO

(Chief Forest Products Officer, Division of Forestry.)

THE use of South African timbers up to 1927 resolved itself largely into mining and fuel requirements, with only a small quantity finding its way into industry, and much timber was actually left to rot in forests and plantations.

Rational conversion at the Forest Products Institute, Pretoria West, commenced with particular attention to seasoning and preservation so as to ensure satisfactory behaviour and long life. A study of physical and mechanical properties disclosed numerous potential uses subsequently substantiated by service tests, but marketing research and development was found necessary to overcome prejudice and secure a foothold on the local markets.

After years of uphill work it is gratifying to record that material progress has been made. The demand for the better known indigenous woods has been stimulated at increased prices, Stinkwood having risen from a beggarly market at 7s. per cu. ft. to take its place as one of the most costly luxury timbers in the world. There was no market for Kiaat fifteen years ago yet to-day the demand cannot be met. Many entirely unknown timbers like Cape Ebony have been introduced for such existing purposes as slide rules and other high priced articles.

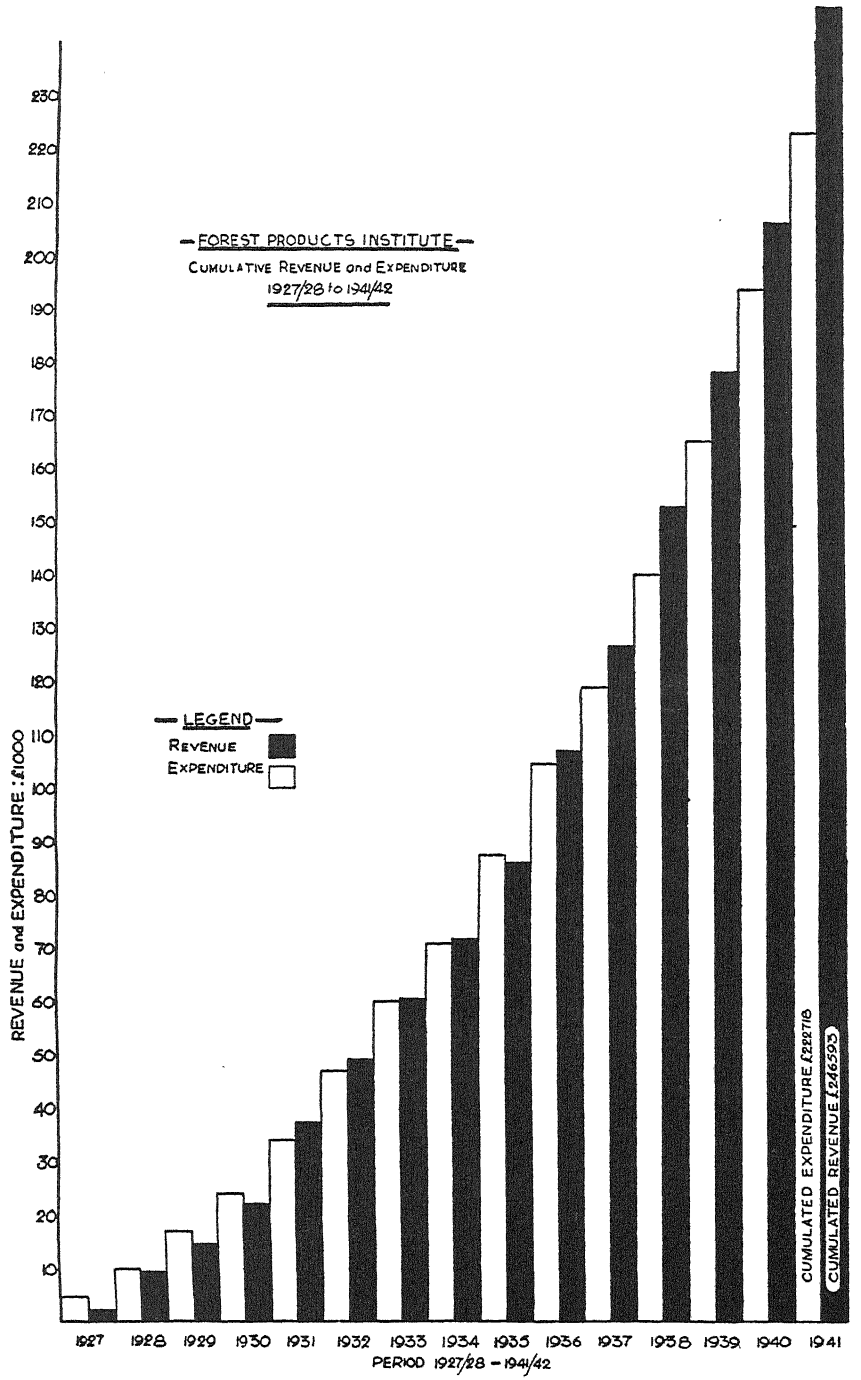
The utilization of *immature* hardwoods like the eucalypts before 1927 was not successfully attempted in any country and South Africa may well take credit for being the first to introduce it in the form of high class flooring, joinery, furniture, heavy construction, spring boards, tennis rackets, and other articles too numerous to mention.

South Africa was also the first to introduce the chemically treated immature gum pole that is now so familiar a sight in fences and in telephone and power transmission lines, and it is only now after many years of experimentation and large scale demonstrations that other countries, including Australia, to which the genus is indigenous, are beginning to follow suit.

As far as softwoods are concerned the results have been equally encouraging, the seasoned wood being found perfectly reliable for numerous purposes such as scantlings, flooring, ceiling, weather boarding, shingles and box shooks. Large scale tests of patula citrus boxes sent overseas was a particularly interesting demonstration proving the qualities of this wood in direct comparison with the usual Baltic timbers.

The results of the many experiments of which only a few are briefly mentioned above were sufficiently conclusive to encourage the erection of many softwood sawmills and one hardwood mill by the Government.

In addition to technical studies of wood properties and conversion to experimental products, the Institute's staff has conducted investigations



Fifteen years' marketing research in South African timbers.

in paper making, charcoal burning, destructive distillation, glueing of wood, bending and so forth.

The work at the Institute falls into two categories, of which one deals with technical investigations of a non-remunerative character and the other with workshop operation for the production of experimental test materials as required and materials for sale.

The total staff has consisted of late years of 35 europeans and 125 natives. The cost of the daily paid portion of this staff, maintenance and operation, together with the cost of timber from different parts of the Union, has been provided annually from Revenue Funds. The total for the 15 year period under review amounted to £223,000 and the revenue from sale of the various products to £247,000. These are very significant figures and the details of how they are made up from year to year is shown diagrammatically on the accompanying chart. There are several striking features which deserve particular reflection.

1. The expenditure of the Institute has been more than offset by revenue, thus disproving the usual belief that technical investigations must of necessity be a serious financial burden on the community.

2. The sale of these experimentally produced articles is a tangible public acknowledgement that the experiments have been of practical value.

3. During the years of serious depression to many timber merchants dealing in imported timbers, the demand for our products was consistently maintained at no reduction in prices.

It may be said in conclusion therefore that the future prospects of properly manufactured South African timber as indicated by the Institute's marketing research and development during the last 15 years is certainly encouraging.

DIE BEDREIGING VAN HOUTWURM-AANVAL IN BOUHOUT EN DIE VOORKOMING DAARVAN

DEUR P. M. D. KROGH

(Senior Tegniese Assistent, Bosprodukte-Inrigting, Pretoria.)

DIE omvang van insektebeskadiging aan loofhout, d.w.s. hardehoutsoorte, word maar selde ten volle besef. By die Bosprodukte-Inrigting, Pretoria-Wes, is hierdie saak, die onderwerp van 'n spesiale ondersoek gemaak. In die proewe is duisende kubieke voet hout met verskillende chemikalieë behandel en die behandelde hout daarna deur die hele Unie versprei ten einde die betreklike doelmatigheid daarvan onder dienstoestande uit te toets en sodoende vas te stel watter skeikundige stof die beste verduursamingsmiddel is.

Die belangrikheid van houtbewaring in Suid-Afrika word beklemtoon deur die feit dat jaarliks duisende ponde skade deur houtvretende insekte aan hout en houtgeboue aangerig word. Daar is gevalle waar, ten gevolge van skade aan onbewerkte latte wat deur die houtvretende insek veroorsaak was, dat grasdakke afgebreek en met behandelde materiaal herbou moes word, teen groot onkoste vir die kontrakteur of eienaar. Elders weer moes pragtige meubels, paneelwerk en parketvloere, wat honderde ponde gekos het, vervang word. Dergelike teenspoed kan voorkom word, deur die materiaal behoorlik chemies te behandel.

In houtwerwe, waar veel groter voorrade opgehoop word as wat die behandelingsinstallasie kan behartig, het die insekte ruim geleentheid om te vermenigvuldig, met die gevolg dat 'n aansienlike persentasie van die houtvoorrade so beskadig word dat dit alleen maar vir vuurmaakhout gebruik kan word.

Lesers wat bewus is van die gesonde toestand waarin die houtwerk van sommige ou huise in ons land verkeer sal geneig wees om te dink dat hierdie waarskuwing onnodig skrikwekkend is. Hulle moet dit egter nie vergeet nie dat die vloere en vaste houtwerk van moderne geboue van een of ander soort loofhout is, terwyl vorige geslagte in ons land meesal naaldhout gebruik het—en naaldhout (byvoorbeeld denne- of sipreshout) is onvatbaar vir aanvalle van die mees wydverspreide van alle houtvretende insekte wat ons hier teister.

Die kernhout van sekere soorte loofhout word weliswaar nie aangeval nie, maar die spinthout van die meeste loofhoutsoorte is baie vatbaar. Spinthout kan nie altyd met voordeel verwerp word nie, en natuurlike duursaam soorte is dikwels nie verkrygbaar nie. In die verlede was die houtwurm ook nie so wyd oor die land verspreid nie. Toestande verander en dit is tans nodig om nuwer metodes aan te wend ten einde die gevaar wat hulle inhou die hoof te bied. Dit ly geen twyfel dat hierdie besondere gevaar vandag met rasse skrede toeneem.

Voorkoming van Besmetting

Besmetting kan voorkom word as die hout in kreosoot of in 'n 5%-oplossing van sink-chloride of sinksulfaat geplaas word, wat tot 180° F. verhit moet word en dan toegelaat om af te koel sodat die hout die kreosoot of metaalsout-oplossing kan absorbeer. Materiaal so behandel en dan weer gedroog word voordat dit in gebruik geneem word, is volkome teen insekteaanval beskerm, mits dit nie blootgestel word aan toestande wat uitloging veroorsaak nie. As die verduursamingsmiddel uitloog, wat dit ook geneig is om te doen as die behandelde hout in aanraking met water kom, sal sy beskermende eienskap verminder en mettertyd heeltemal geen waarde hê nie. Wat betref al die chemikalieë wat maklik in water opgelos kan word, kan sulke omstandighede dus ernstige nadele hê, maar met kreosoot is dit van weinig betekenis. Hout wat slegs in sterk oplossings gedoop is, verkry net oppervlakkige beskerming wat glad nie meer effektief is nadat onbehandelde oppervlaktes blootgestel word nie. Kreosootbehandelde hout en in mindere mate, ook materiaal wat met sink-chloride en sinksulfaat behandel is, was na 19 jaar diens nog onbeskadig.

Behandeling van Besmette Hout

Daar kom gevalle voor waarin hout wat vir gebruik bestem is, reeds met houtwurm besmet is. In sulke gevalle is dit nutteloos om die hout net in oplossings te doop, of daarmee te bestryk, of ander oppervlakkige behandeling te gee. Alhoewel volle behandeling alles wat in die hout leef sal doodmaak, word die raadsaamheid van behandeling deur ander faktore bemoeilik. Hoewel die aanwesigheid van uitkomgaatjies in die hout, en van houtpoeier naby die gaatjies of op omliggende materiaal 'n aanduiding is daarvan dat houtwurms inderdaad in die hout werksaam is, beteken die afwesigheid van maklik sigbare gaatjies nie noodwendig dat die hout onbesmet is nie, aangesien die larwes onder 'n oënskynlik gesonde oppervlakte aan die werk mag wees. Van die hoeveelheid gaatjies, en die oppervlakte wat hulle beslaan, kan die omvang van die aanval eers geskat word. As uit hierdie aanduidings afgelei word dat die aanval uitgebreid is, moet die materiaal verwerp word. Of dit wel nodig is, kan maklik vasgestel word deur die aangetasde gedeelte met 'n hamer te slaan, of die spinthout daar oop te breek. In die eerste geval sal die slae 'n dowwe geluid afgee of die houtpoeier laat opstuif, en in laasgenoemde geval sal die vernielingswerk van die wurms blootgelê word. Bouhout wat so straf aangetas is, is onveilig en moet verwerp word.

Hoewel die ondersoek van hout na die tekens van houtwurmaanval baie ingewikkeld mag voorkom is dit in werklikheid heeltemal eenvoudig en vereis dit slegs 'n bietjie ondervinding, sonder enige spesiale kennis. Die moeite en onkoste is gering en word ruim vergoed deur die ontdekking van gevaarlik besmette materiaal, wat dan verwerp kan word.

As daar geen beswaar teen verkleuring van die hout is nie, kan 'n aanval deur toepassing van enige standaard-metode van verduursaming gestuit word. Aangesien verskillende behandelings verskillende soorte hout op verskillende maniere aantas, is dit veiliger om voltooide artikels wat weens hulle voorkoms van waarde is, by wyse van inspuiting te behandel. Met 'n groot onderhuidse spuit, waarvan die naald net sowat

$\frac{1}{8}$ duim deur die end van 'n rubberprop uitsteek, word gelyke dele paraffien en terpentyn in die uitkomgaatjies (d.w.s. die gaatjies waar die hopies houtpoeier verskyn) ingespuit. Alle gaatjies, oud en nuut, word so behandel. Die naaldpunt word in die gaatjie geplaas, die rubberprop vas teenaan die hout gedruk, en soveel vloeistof moontlik ingepers. Hierdie behandeling moet na twee of drie dae herhaal word, en weer, indien nodig, totdat geen poeier meer uitkom nie. Daarna moet die hout vir geruime tyd dopgehou word, sodat enige verdere aanval dadelike stopgesit kan word. Aangesien die larwes en volwasse insekte dan vernietig is, is verdere aanvalle onwaarskynlik as die hout goed met waspolitoer gepoets, of vernis of geverf word.

Keuse van Verduursamingsmiddels

Kreosoot.

Kreosoot is baie doeltreffend teen houtwurm, termiete, verrotting en verwering. Dit kan met gerustheid teen baie strawwer toestande aangewend word as die metaalsoute, en word derhalwe verkies vir bouwerk in die buitelug, veral waar die hout in aanraking met die grond kom. Ongelukkig bly die oppervlakte van kreosoot-behandelde hout vir 'n tydlank olierig en is dit vir sekere doeleindes ietwat onooglik, maar in die geval van stalle, drukgange, heinings, telefoonpale, elektriese oordra pale, en brugge is hierdie eienskappe van geen belang. Kreosoot word tans in Suid-Afrika vervaardig ooreenkomstig 'n Amerikaanse standaardspesifikasie. Absorpsie van hierdie kreosoot teen 'n minimum van 5 pond per kubieke voet hout is wenslik. Die doelmatigheid van die middel kan verhoog word deur vir elke 5 pond kreosoot 1 pond brandstofolie deeglik by te meng. Dit sal die neiging van die hout om barste na binne onder die behandelde oppervlakte van die hout te vorm, teenwerk. Sulke barste stel onbehandelde gedeeltes aan insekte-aanvalle en verrotting bloot.

Metaalsoute.

Sink-chloride en sinksulfaat is soute wat maklik in water oplosbaar is, en vir effektiewe verduursaming is dit nodig dat hout 'n minimum van $\frac{1}{2}$ pond droë sout of sowat 'n gallon van 'n 5%-oplossing moet absorbeer. Uit ondervinding blyk dit dat hierdie soute, onder toestande waar uitloging geen rol speel nie, in Suid-Afrika doeltreffend is teen houtwurm en verrotting maar minder effektief teen termiete.

Waar metaalsout-behandelde hout nie aan termietaanvalle of oormatige vogtigheid of buitelugtoestande blootgestel word nie, soos in die geval van dakbalke, vloere en deure, behou dit die verduursamingsmiddel vir 'n onbepaalde tyd en word dit vir alle praktiese doeleindes onvernietigbaar.

Ander chemikalieë

Daar is talle ander verduursamingsmiddels, skeikundige stowwe en eiendomspraparate op die mark, maar hulle is gewoonlik baie duur, moeilik verkrygbaar, en hulle betreklike waarde onder Suid-Afrikaanse toestande nog nie bepaal nie.

VERDER INLIGTING

Onderstaande pamflette oor die verduursaming van hout is op aansoek verkrygbaar by die Hoof-Bosproduktebeampte, Posbus 727, Pretoria:

,,Houtpreservering,'' deur J. H. van Wyk en P. J. A. Loseby.

,,Verduursaming van Timmerhout op die Plaas,'' deur J. H. van Wyk.

,,A Gravity Method of Preserving Green Wood,'' by Nils B. Eckbo.

Pamflette 1 en 2 beskryf die behandeling van gedroogde hout; in pamflet No. 3 gee die skrywer 'n beskrywing van 'n goedkoop verduursamingsbehandeling vir klein stukke groen hout.

CORRESPONDENCE
KORRESPONDENSIE

CAESAR'S BRIDGE

To the EDITOR

Sir,

For those of your members and readers who still remember enough of their Latinity to read Caesar there is a pretty timber problem connected with his account of the wooden bridge he threw over the Rhine in the year 55 B.C. in order to put the fear of the Roman *imperium et auctoritas* into the truculent German tribes who, like their Nazi descendants, persisted in invading Gaul in search of lebensraum and plunder.

To make my query plain, I must ask your indulgence for a little introductory recalling of the main points. Caesar chose a spot, on the western or left bank of the river, which spot is generally identified as being somewhere near Bonn or on the similar stretch of comparatively open country between Coblenz and Andernach. Wherever the site, it would offer an easy approach from a fairly level take-off, the water would not be too deep—perhaps fifteen feet—and the current, though still sufficient to need to be taken into serious account, would not be too rapid. It is as well to bear in mind what, of course, everyone knows, that the great stream then ran an uncanalised course, and presented broad ungirt expanses of perhaps twelve to sixteen hundred feet or more in width.

Having chosen his site, Caesar set his men to work, using, doubtless, the rank and file of legionaries under the superintendance of *fabri* or engineers. Unquestionably, there were forests of notably tall trees close to hand. They were of height and clear girth to give him, according to generally accepted estimates, anything up to two hundred piles of eighteen-inch diameter and fifty beams forty feet long and with a uniform measurement of twenty-four inches across. Whether these latter would need to be roughly squared is a moot point, to be considered in the light of the speed of the work, which took no more than ten days from start to finish.

The frames were built in the form of a truncated capital " A," cut just above the horizontal member—the length of the legs varying according to their position across the river-bed. These legs were sharpened at the lower ends and lashed in pairs, two feet apart, inside measurement. Prepared on the bank, the pairs were lowered into the water, probably with block and tackle, and driven home with pile-drivers, so that the contrary pairs leaned towards each other. They were then joined by lowering between the tops of the piles great beams or trunks, forty feet by two feet, that rested on horizontal cross-pieces. The beams were made fast at the ends, and the resistance of the frames to the force of the current was reinforced by other piles. The result was, as Caesar

triumphantly declares, that the greater the downward rush of the river, the more strongly the frames were braced to take the strain.

The frames were joined together by long straight spars or poles, over which, again, hurdles were laid, closely woven of lighter branches. So, it would seem, most of the parts of the felled trees were used, an assumption that may serve as a clue to the kind or kinds of trees employed.

Few passages in Caesar have been so often and so variously interpreted and theorised upon as this by all sorts of people, including Napoleon himself, whose interpretation, it is disappointing to note, is as little satisfactory as that of the most academic scholiasts. But, as far as I am aware, no one has yet attempted to identify the trees themselves. It is upon this question, Mr. Editor, that I venture to appeal to your technical and scientific readers for assistance. It is a matter that relates interestingly to the early forest-history of the Rhine Valley.

Yours faithfully,

J. P. R. WALLIS.

THE VALUE OF AN IMMATURE PLANTATION

To the EDITOR

Sir,

Arising out of an article entitled "The Valuation of an Immature Plantation" appearing in your April, 1941, issue, and correspondence thereon in subsequent issues, I would like to put the following questions:

(1) How would Mr. O'Connor arrive at the value of an immature crop which was established, without cost to the owner, from self-sown seed?

(2) Mr. O'Connor says that he accepts the compound interest formula because it gives systematic form to a line representing values he can accept. Now (please refer to the chart accompanying the original article) suppose that for some reason the cost of formation was £32·83 per acre (not £3·25). The investment would then earn 5%, and intermediate values as fixed by the compound interest formula would lie along the line A.B—a line which is practically straight. Would Mr. O'Connor regard this line as representing values he can accept—i.e., values rising slowly at first and then more and more rapidly according to the time the risks involved operate?

(3) Mr. O'Connor says further that he sees no compulsion to bring interest into the matter at all. How otherwise would he arrive at a line curved so that it represents values he can accept?

INTERESTED.

Mr. O'Connor replies:

It must not be supposed that, because I made a small contribution on forest valuation,—truly a case of a fool rushing in, etc.—I am able satisfactorily to answer all sorts of questions on this debatable subject. "Interested," however, raises a few pertinent points which I shall deal with as best I can.

(1) If I have a plantation, newly established from self-sown seed, and someone destroys it, I would be entitled to claim from the culprit the expenditure necessary to put me in the position I was in before the act of destruction—i.e., the cost of artificial establishment. Looking at

the matter from a slightly different angle, suppose I spend £3 per acre in planting an area (first crop). At the end of the rotation the crop is exploited and I am left with a stand of seedlings naturally regenerated at no further cost to myself. The value of the new crop is merely a perpetuation of the original value to secure which I spent £3.

It seems to me therefore that the cost of artificial establishment can in all cases fairly be used for calculating intermediate values. This, however, subject to the remarks in the next paragraph.

(2) No one would invest a sum of money earning only 5% interest unless the final return is reasonably certain. To arrive at the "immature value" of such an investment would then be merely a matter of discounting down an *assured* future value. This type of investment is not to be associated with one like tree planting where there are risks to be faced. Cost value as applied to a plantation therefore does not come into the picture in this case.

I suppose an actuary, having sufficient data from similar undertakings, could calculate the minimum per cent. earning that would justify the risks attached to tree planting. The final value discounted down to the year 0 with that percentage would give the maximum initial cost which could be accepted for valuation purposes. The compound interest formula with the rate of interest no lower than would justify the risks would then give a line representing values which can be accepted.

(3) Instead of using the compound interest formula, let us consider the graph of the equation $y = c + ax^2$ where

y = value of the plantation.
c = cost of establishment.
a = a constant.
x = age.

When x is the age at the end of the rotation, $ax^2 + c$ would represent the final value, and a would be final value $- c$ divided by x^2 (the square of the rotation length).

The graph of the above equation would be a line representing values which we can accept in that the values would at first rise slowly and thereafter more and more steeply in conformity with the time the risks involved operate. As in the case of the compound interest formula, a condition is that the difference between initial cost and final value must be large enough to justify the risks. The equation can be used even when c is zero—i.e., if we prefer to regard a self regenerated stock as having no initial cost value.

For the purposes of illustration take the data on the chart which accompanied by original article. Here c = £3·25; and $a = \frac{£48{\cdot}5 - 3{\cdot}25}{8 \times 8}$ = £0·707. The value of the plantation y in the 4th year would therefore be $y = c + ax^2 = 3{\cdot}25 + 0{\cdot}707 \times 4 \times 4$ = £14.56 per acre.

The only reason for preferring £12·55 per acre as the value of the plantation in the 4th year is that it is arrived at in terms of interest earned, otherwise, as far as I can see, there is no compelling reason why it should be accepted rather than £14·56 per acre.

To the EDITOR

Sir,

The parable presented by Mr. O'Connor in his reply to my letter in your last issue is amusing, but, in my opinion, irrelevant. In Mr. A.'s

proposition, the value of the land is expressed in the expectation value. If claimant had selected a second, instead of a first, quality site for his venture, his anticipated final yield might quite conceivably have been only a third of that accepted by the Court. The comparative anticipated yields would reflect the comparative value of two areas of land, and some function of the individual absolute value of either must therefore have direct expression in its expectation value. Now, if the value of the land is expressed in the expectation value, cost value at the same rate of interest at which the final value is discounted, must take it into consideration also.

The case of the widow cited by N.L.K.'s legal friend differs from that under consideration in that the value of her husband during his lifetime varied from year to year. His was a wasting value, whereas that of land, judiciously managed, is not. The widow could not unblushingly offer her husband for sale 10 years after purchase at the same price originally paid by her; whereas in ordinary circumstances she might sell her farm after the same interval without any loss.

The professional opinion quoted I find on the whole disappointing. The main point in this discussion, that is, whether damages in respect of a burnt out plantation may legally be assessed on an expectation basis, is evasively relegated by N.L.K.'s consultant to determination by "common sense," and common sense opinion is lay opinion, of which out of the mouths or pens of lay-imagined magistrate, counsel, claimant, defendant and expert witness, and of Messrs. "A," O'Connor, N.L.K. and myself you have, I expect, already had enough.

Yours faithfully,

LAIRD.

REVIEWS

UNION OF SOUTH AFRICA: REPORT OF THE DIVISION OF FORESTRY FOR THS YEAR ENDED 31ST MARCH, 1941.

This report of eighteen foolscap pages is half the length of that of 1939-40, and even less compared to former years, but it has lost neither interest nor value on that account.

War conditions led to a large reduction in the silvicultural programme. The activities of the Division were directed mainly to making use of all available home-grown timber and reducing imports to a minimum. The limiting factor in this effort, it is stated, was not lack of timber, but of machinery. Despite the difficulty of importing machinery, several new State mills came into operation, while arrangements for erecting others were in hand. Stimulation of output by private enterprise was aimed at, but with the demand for manufactured timber so active, the question arises as to whether, perhaps, more might have been done to promote the establishment of private in preference to State mills, a policy which the Division has advocated strongly hitherto. So favourable an opportunity may not soon recur, and the Division may find itself involved more and more in a purely manufacturing enterprise, which foresters as a general rule shun.

The total output of all classes of timber from the plantations was rather over 13,500,000 cubic feet, of which 6,750,000 were softwood saw logs over 5 inches in diameter. Private mills used about 4,000,000 cubic feet, and State mills approximately 2,750,000. The output was just about 3,000,000 cubic feet more than in 1939-40. In face of these figures the yield of the indigenous forests fades into insignificance. It was but 452,000 cubic feet, a drop of 113,000 cubic feet since the previous year. This furnishes a somewhat crushing reply to those ardent patriots and cranks who have condemned the establishment of plantations of exotic trees.

The price of locally-grown timber rose in sympathy with that of imported, and apparently control of it, as reported in 1939-40, was relaxed, if not abandoned. It is now stated " that the only rational way of securing an equitable distribution of the benefits to be derived from State-owned timber is to sell it at the best price obtainable, so that the proceeds can go into the pocket of the general public where they belong." Under the present capitalist system the soundness of that attitude cannot be questioned; it should salve the conscience of the Division in accepting a price of 28s. 9d. per cubic foot for Stinkwood in the log, and save it many headaches in trying to fix fair prices by other methods.

Revenue reached a new high level. Collections totalled £372,000 in cash and £79,000 in gratis issues, increases of £123,000 and £31,000 respectively over the previous year. The increases were mainly derived from expanding sales from plantations and from the State saw-mills.

It should be remembered these figures show gross returns, and the report does not give any indication as to what net returns were. Expenditure on all votes reached £666,000, an increase of £13,000 over 1939-40, which itself showed a rise of £80,000. The reason for the growth in expenditure is not stated, but with a reduction of 372 in the number of employees in the forestry camps the growth is certainly remarkable.

Planting plans were prepared for six plantation areas, and a further two were revised, but it is not reported whether any were sanctioned. Compared to last year the area afforested dropped by 6,420 acres to 7,000 acres; 85 per cent. of the species planted were conifers, 13 per cent. were eucalypts, and 2 per cent. other kinds; 38,000 acres of plantations were thinned, and just half that area pruned; 22,000 acres were cleaned, 18,000 weeded, 478 replanted and 220 inter-planted.

Nine hundred and thirty-six acres of indigenous forest were cleaned and 70 acres were inter-planted. The disposal of plants and seeds to the public exceed last year's sales. At the Division's wood preservation plants, including the one at the Forest Products Institute, over 500,000 cubic feet of timber were treated and used mainly for transmission, telephone, fence and building poles. The quantity of Wattle bark exported constituted a record for the industry, and to save shipping space the ratio of extract to bark sent away was almost double that of the previous year.

On account of the war, research work was considerably curtailed, though the measuring and recording of data for all important projects was maintained. Volume tables, percentage utilization tables, taper tables and bark thickness tables for the seven main coniferous exotic species were completed and await publication. It is noted that research was carried out on 400 specimens of *Pinus teocote* timber, but it is questionable, indeed extremely doubtful, whether that species exists in the Union. Surely something might have been done in the last ten years to clear up the identities of Mexican species on the lines suggested by Robertson in his very able report on the subject. It would at any rate seem premature to initiate research in a species before its identity has been verified. Reconnaissance showed that the control of the Eucalyptus Snout beetle (*Gonipterus scutellatus*) by the introduced mymarid egg parasite has made greater strides during recent years than had been realized. Economic control has been effected over a wide area.

The Forest Influences research at Jonkershoek was curtailed, and all work at the Drakensberg Station was suspended for the duration of the war. The commercial activities of the Forest Products Institute were further developed for war purposes; good progress was made in experimental work and data in connection with conversion yields and costs were accumulated. Apparently no very definite research projects were in hand. No statistics of timber imports and exports were published for the year.

Fifty-eight professional and administrative officers, as well as a large number of daily-paid employees, were released for military service.

C. E. LEGAT,
The Empire Forestry Journal,
Vol. 21, No. 1, 1942

Die

Tydskrif van die Suid-Afrikaanse Bosbouvereniging

April

UITGEGEE DEUR DIE VERENIGING
April en Oktober

The

Journal of the South African Forestry Association

April

PUBLISHED BY THE ASSOCIATION
April and October

No. 10. 1943
PRETORIA
6/-

SUID-AFRIKAANSE BOSBOUVERENIGING

Beskermheer:

SY EKSELLENSIE DIE GOEWERNEUR-GENERAAL,
DIE HOOGEDELAGBARE SIR PATRICK DUNCAN,
G.C.M.G., K.C.

President:

DIE EDELAGBARE KOLONEL DENEYS REITZ, L.V.

Vise-Presidents:

DIE EDELAGBARE KOLONEL W. R. COLLINS, D.T.D., D.S.O., L.V.

HANS MERENSKY, DR.ING.H.C., D.SC.

H. J. VAN DER BIJL, PH. D., D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.

P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.

C. E. LEGAT, C.B.E., B.SC.

J. HUNT HOLLEY.

T. M. MACKENZIE.

AMPSDRAERS:

Voorsitter: A. J. O'CONNOR, DIP.FOR.

Vise-Voorsitter: F. E. B. STRUBEN.

Ere Redakteur: J. M. TURNBULL, M.M., DIP.FOR.

Ere Sekretaris-Tesourier: P. E. DU PREEZ, B.A., B.SC.

Uitvoerende Komitee:

A. J. O'CONNOR, DIP.FOR. (*Voorsitter*).

F. E. B. STRUBEN (*Vise-Voorsitter*).

I. J. CRAIB, M.F., PH.D.

H. A. LORENTZ, LL.D.

W. E. WATT, A.F.C., B.A., DIP.FOR.

J. M. TURNBULL, M.M., DIP.FOR. (*Ere Redakteur*).

P. E. DU PREEZ, B.A., B.SC. (*Ere Sek.-Tes.*).

SOUTH AFRICAN FORESTRY ASSOCIATION.

Patron:

HIS EXCELLENCY THE GOVERNOR-GENERAL,
THE RIGHT HON. SIR PATRICK DUNCAN, G.C.M.G., K.C.

President:

COLONEL THE HONOURABLE DENEYS REITZ, M.P.

Vice-Presidents:

COLONEL THE HONOURABLE W. R. COLLINS, D.T.D., D.S.O., M.P.

HANS MERENSKY, DR.ING.H.C., D.SC.

H. J. VAN DER BIJL, PH. D., D.SC., M.AM.I.E.E., F.I.R.E., F.R.S.S.AF.

P. R. VILJOEN, M.R.C.V.S., DR.MED.VET.

C. E. LEGAT, C.B.E., B.SC.

J. HUNT HOLLEY.

T. M. MACKENZIE.

OFFICERS:

Chairman: A. J. O'CONNOR, DIP.FOR.

Vice-Chairman: F. E. B. STRUBEN.

Hon. Editor: J. M. TURNBULL, M.M., DIP.FOR.

Hon. Secretary-Treasurer: P. E. DU PREEZ, B.A., B.SC.

Executive Committee:

A. J. O'CONNOR, DIP.FOR. (*Chairman*).

F. E. B. STRUBEN (*Vice-Chairman*).

I. J. CRAIB, M.F., PH.D.

H. A. LORENTZ, LL.D.

W. E. WATT, A.F.C., B.A., DIP.FOR.

J.M. TURNBULL, M.M., DIP.FOR. (*Hon. Editor*).

P. E. DU PREEZ, B.A., B.SC. (*Hon. Sec.-Treas.*).

REDAKSIE-KOMITEE.

J. M. TURNBULL, M.M., DIP.FOR.—*(Voorsitter.)*

I. J. CRAIB, M.F., PH.D.

NILS B. ECKBO, M.F.

A. J. O'CONNOR, DIP.FOR. *(Ex officio).*

D. B. VAN SOELEN, B.A., LL.B.

Artikels oor alle aspekte van bosbou sal deur die Redaksie-Komitee in oorweging geneem word, en moet aan die Redakteur, ,,Die Tydskrif van die Suid-Afrikaanse Bosbouvereniging,'' Posbus 727, Pretoria, gerig word. Artikels van meer as 1,000 woorde moet van 'n opsomming waarvan kopiereg nie voorbehou is nie, van nie meer as vyf persent van die lengte van die artikel self vergesel word. Twaalf herdrukke van elke artikel sal kosteloos aan die skrywer daarvan verskaf word. Mits hulle bestel word voor die einde van die maand voorafgaande dié van uitgawe, kan herdrukke bo hierdie hoeveelheid teen die volgende pryse vir eenhede van vier teksblaaie verkry word:—

100	*kopieë*	*£0 16 6*
250	*,,*	*£1 5 6*
500	*,,*	*£2 0 6*
1,000	*,,*	*£3 10 6*

Onvolledige eenhede sal teen dieselfde prys as volledige eenhede gereken word. Gedrukte omslae, bestel belyktydig met die herdrukke, sal voorsien word ten 21/6 per 100, en 2/- per elke 50 bo die eerste 100. Illustrasies ekstra.

Kontribusies sal gepubliseer word in die taal waarin hulle ingestuur word. Opsommings mag in enige of beide amptelike tale ingedien word.

Die Vereniging neem geen verantwoordelikheid aan vir die bewerings of opinies van skrywers nie.

Lesers word versoek om die Vereniging se adverteerders waar gerieflik, in aanmerking te neem.

EDITORIAL COMMITTEE.

J. M. TURNBULL, M.M., DIP.FOR.—*Chairman.*

I. J. CRAIB, M.F. PH.D.

NILS B. ECKBO, M.F.

A. J. O'CONNOR, DIP.FOR. *(Ex officio).*

D. B. VAN SOELEN, B.A., LL.B.

Contributions on any aspects of forestry or allied subjects will be considered by the Editorial Committee, and should be addressed to the Editor, The Journal of the South African Forestry Association, P.O. Box 727, Pretoria. Articles in excess of 1,000 words should be accompanied by uncopyrighted summaries, not exceeding five per cent. of length of originals. Twelve reprints of each article will be furnished to its author, free. Reprints beyond that number may be obtained, if ordered before the end of the month preceding that of issue, at the following rates per unit of four text pages:—

100 copies	*£0 16 6*
250 ,,	*£1 5 6*
500 ,,	*£2 0 6*
1,000 ,,	*£3 10 6*

Incomplete units will be charged as for complete units. Printed covers ordered at same time as the text will be provided at 21/6 per 100, and 2/- for every 50 in excess thereof. Illustrations extra by arrangement.

Articles will be published in the language in which they are submitted. Summaries may be submitted in either or both official languages.

The Association does not hold itself responsible for statements or views expressed by authors.

Readers are urged to consider the Association's advertisers as occasion may arise.

INHOUD—CONTENTS.

Die Vereniging neem geen verantwoordelikheid aan vir bewerings of menings wat deur skrywers uitgespreek mag word nie. Met uitsondering van skrywers se opsommings, word kopiereg van alle artikels voorbehou.

The Association does not hold itself responsible for statements or views expressed by authors. With the exception of authors' summaries copyright of all articles is reserved.

BLADSY
PAGE

VAN DIE REDAKSIE—EDITORIAL NOTES AND COMMENTS 1

CHANGES AT FORESTRY HEADQUARTERS.

FOREST PRODUCTS INSTITUTE.

DIE HOUWHOEKSE BLOEKOM.

THE HOUWHOEK BLUEGUM.

PROGRESS OF FOREST ENTOMOLOGY IN SOUTH AFRICA, *by F. C. G. Tooke, M.Sc.* 4

THE VARIABILITY OF JONKERSHOEK STREAMS, *by C. L. Wicht, B.Sc., B.A., Dr.Ing.* 13

NOMENCLATURE OF THE SOUTH AFRICAN YELLOWWOODS. INTRODUCTION WITH NOTES ON DISTRIBUTION, *by J. J. Kotze, B.A., B.Sc.* NOMENCLATURE OF *Podocarpus* SPECIES, *by C. A. Smith, B.Sc.* 23

SOME WEST AFRICAN SUBSTITUTES FOR WELL-KNOWN TIMBERS, *by M. H. Scott, B.Sc.* 29

HISTOLOGICAL DISTRIBUTION OF WATTLE BARK TANNIN, *by H. A. Luckhoff, B.Sc., M.Sc.* 40

A SYSTEMATIC BASIS FOR WOOD-USES RESEARCH, *by John M. Turnbull, Dip.For.* 51

CORRESPONDENCE 60

ANTI-STAIN SOLUTIONS.





DIE HOUWHOEKSE BLOEKOM.

DIE TYDSKRIF VAN DIE
SUID-AFRIKAANSE BOSBOUVERENIGING
No. 10. APRIL, 1943.

THE JOURNAL OF THE
SOUTH AFRICAN FORESTRY ASSOCIATION
No. 10. APRIL, 1943.

VAN DIE REDAKSIE
EDITORIAL NOTES AND COMMENTS

CHANGES AT FORESTRY HEADQUARTERS.

We have to congratulate the Association's Chairman, Mr. A. J. O'Connor, on his appointment on the 26th. December as successor to Mr. J. D. M. Keet as Director of Forestry for the Union. Mr. O'Connor was one of the first forest officers to receive professional training in South Africa, having attended the first course in forestry initiated at the old "South African School of Forestry" at Tokai and the South African College, Cape Town, in 1905. After graduating in 1908 he was appointed Assistant District Forest Officer at Tokai, later in the same year being transferred to Umtata and attached for special duties to the Transkeian Territories General Council. After a further period of district and working plan duties in the Midland Conservancy, he was appointed successively A.D.F.O. and D.F.O. at Woodbush, in the Northern Transvaal, the headquarters of a district that has since been split up into the Pietersburg, Louis Trichardt, Tzaneen, Sabie, Graskop and White River forestal districts. From the Transvaal he proceeded on promotion in 1927 to Pietermaritzburg, where he assumed the duties of Conservator of Forests for Natal. He became later Conservator for the Transvaal, and was promoted to Assistant Director of Forestry in 1936. Mr. O'Connor is an authority on forest management and forest botany, in which latter sphere he is commemorated in the name of the timber species *Ochna o'connori* Phill. Certain of his publications, particularly his *Forest Research with Special Reference to Planting Distances and Thinning,* have aroused considerable interest in forestry circles both overseas and at Home. We wish him every success in his important and influential new appointment.

To his indefatigable predecessor we were about to wish long enjoyment of a well-earned leisure, had it not occurred to us that such a word must have been expunged from his dictionary long before he and Mr. O'Connor

together attended the same course in forestry at Tokai. After graduating, Mr. Keet was detailed for working plan duties in the Eastern Conservancy of the Cape, and was shortly thereafter appointed Acting D.F.O. at Keiskama Hoek. In 1915, he was transferred to Knysna, a district which in the course of eight years' unremitting application he brought to a pitch of adminstrative and technical efficiency that has ever since set the pace in district control. In 1923 he was appointed Conservator for the Transvaal with headquarters at Pretoria, and succeeded Dr. F. E. Geldenhuys as Director of Forestry in 1935. In the same year the degree of Master of Science, *honoris causa,* was conferred on him by the University of Stellenbosch.

An athlete of some note in his younger days, Mr. Keet, in his fifties, at the end of a strenuous day's inspection duties could still outmarch many of his younger subordinates, and a similar tirelessness characterises him in his more sedentary occupations. In spite of his retirement as Director of Forestry, he will retain his association with forestry matters in his capacity a Timber Controller and as a member of this Association, in the establishment of which he was a prime mover, and of which he was first Chairman. With the Divison of Forestry the association will be in an official advisory capacity. Whether at leisure or strenuously coping with his still onerous duties, Mr. Keet carries with him into retirement from his Directorship our warmest wishes.

To Mr. W. E. Watt, a member of the Association's Executive Committee and its first Honorary Secretary-Treasurer, previously Conservator of Forests for the Transvaal, who succeeds Mr. O'Connor as Assistant Director of Forestry, we also offer our heartiest congratulations.

FOREST PRODUCTS INSTITUTE.

Certain commercial activities carried out during the last 16 years at the Forest Products Institute, Pretoria West, have contributed largely towards the wearing down of the apathy and prejudice that had hitherto denied to South African grown timbers the markets they might otherwise have earlier secured. Having established the economic importance of the more readily available of these timbers, these activities have now been relegated to the large new commercial plant that has been brought into commission by the Division of Forestry on ground abutting on that of the Institute. The Institute will henceforth concentrate its attention essentially on research, to which the marketing development referred to above has in the past been incidental. The retirement on pension last January of Mr. Nils B. Eckbo, first Chief Forest Products Officer for the Union, under whose capable administration and sympathetic and helpful attitude towards the Public the Institute has acquired its present wide reputation in mercantile, industrial and State circles, both at Home and abroad, as well as amongst artists and amateur wood-workers, more or less coincides with this change.

The growth of the Institute from a pair of small experimental seasoning kilns at the Pretoria Railway workshops, and an experimental wood preservative station situated behind the New Transvaal Museum, in Minnaar Street, to its present-day proportions was modestly sketched in a short article in our last issue. Mr. Eckbo's forestry experience commenced in his native Norway, whence he proceeded to the School of Forestry at Yale University, where he specialised in forest utilization, taking the degree of Master of Forestry. After a few years' service with

the United States Government, he was recommended by his department as advisory officer on timber conversion and seasoning to the Union Government, and occupied the post from 1919 until his recent retirement. Mr. Eckbo is another forester who does not gladly throw off the yoke of an attractive bondage, and has established a practice as consulting industrial forester, conducted from Pretoria, in which we wish him every success. His successor is Mr. Malcolm H. Scott, who has assisted him almost from the commencement of the Institute's history.

DIE HOUWHOEKSE BLOEKOM.

As voorblad vir hierdie uitgawe het ons 'n paar portrette van 'n goedbekende landteken te Houwhoek, Afdeling Caledon, laat druk. Ons is deur Dr. C. L. Wicht, van Jonkershoek, aan wie ons baie dank verskuldig is vir die portrette, in kennis gestel dat voordat die boonste 50 voet van hierdie reusagtige voorbeeld van die Australiese bloekom (*Eucalyptus globulus*) in 1933 afgekap is, dit 'n totale hoogte van 142 voet bereik het. Tans is die omvang daarvan op borshoogte 21.5 voet, en is dit sowat 110 voet hoog. Wat die ouderdom daarvan betref, kan ons ongelukkig geen inligting plaaslik verkry nie, en sal ons derhalwe baie dankbaar wees as daar enige teenswoordige of vorige plaaslike inwoner is, wat uit jeugdige herinnerings enige inligting oor sy grootte sowat dertig jaar of meer (hoe meer hoe beter) gelede kan verskaf.

THE HOUWHOEK BLUEGUM.

As frontispiece to this issue we print two photographs of a well-known landmark at Houwhoek, Division of Caledon. According to Dr. C. L. Wicht, of Jonkershoek, to whom we are indebted for the photographs, this lordly specimen of the Australian bluegum (*Eucalyptus globulus*), before removal of its top 50 feet in 1933, had attained a height of 142 feet. Its present girth at breast height, he informs us, is 21.5 feet, and its height about 110 feet. Local enquiries have failed to elicit any indication of the tree's age, and we would accordingly be grateful to any past or present resident of the neighbourhood who, from youthful memories, can supply any information regarding its approximate dimensions some thirty or more years ago. The further back the better.

PROGRESS OF FOREST ENTOMOLOGY IN SOUTH AFRICA

By F. G. C. TOOKE

(Forest Entomologist, Division of Entomology.)

THE forest insect section of the Division of Entomology was inaugurated in 1925, and forest insect investigations in South Africa may be said to have started at that time, although studies on the wattle bagworm (*Acanthopsyche junodi* Heyl.) had commenced many years previous to this.

Practical forest entomology in Europe and America has been assisted very greatly by the enormous mass of biological data concerning insects affecting forest trees that has been rapidly accumulated by many students, many of whom were not greatly concerned in the practical application of their work. Several textbooks on forest entomology containing this biological information have been published, and these again have stimulated forest insect investigations to a very marked degree.

In the Union such independent biological investigation has been rare and accordingly progress has been hampered by a lack of definite knowledge of the biology of many species of forest insects.

Forests in South Africa

South Africa has peculiarly little natural forest. Actually there are 16,527 square miles of forest land in the Union, of which only 2,650 square miles are merchantable. This area is made up of 2,323 square miles of broad-leaved species and 327 square miles of conifers.

The area of broad-leaved merchantable forest may be divided into 1,042 square miles of indigenous forest and 1,281 square miles of plantation, mainly eucalypts and tanbark wattles, while the 327 square miles of merchantable coniferous forest consists of exotic species, chiefly pines.

It seems opportune here to sound a note of warning against the ever-increasing tendency to plant up enormous areas with a single species and perhaps with a species which is not quite at home in such areas. Our motto should be, "keep your trees in a vigorous and healthy condition and they will, to a very large extent, take care of themselves"; and in the case of exotics, "fit your trees to the climatic and edaphic conditions of their new habitat and they will remain comparatively healthy." As it is, the advent of a single pine insect of primary importance in our coniferous plantations as they now exist may well spell disaster.

Forest Insects in General

The forests of central Europe have for the last century suffered considerably from fatal outbreaks of lepidopterous defoliators and boring beetles. The forests of the United States and of Canada have to contend against serious epidemics of caterpillar and saw-fly pests and the depredations of bark-beetles, which accompany fire and lumbering

operations. In South Africa, on the other hand, no primary pests are known that are capable of killing healthy trees on a large scale in either natural forests or in plantations, although one species, *Gonipterus scutellatus* Gyll., in the past has so destroyed the growth that trees could not profitably be grown on a commercial scale. In recent years, however, certain secondary pests show a tendency to increase to epidemic incidence and threaten to destroy appreciable areas of plantations.

The control of insect outbreaks spread over hundreds of acres of forest land presents great difficulties with reference both to killing the insects and the expense of the operation. An account of a few important problems will best illustrate the method of investigation and control which are being employed. No mention will be made here of the insect fauna of our indigenous forest, for the simple reason that at no time has sufficient staff been available to work on these problems. This is not to say that such problems are not important, for not only are many of our valuable native timber trees being attacked by borers and defoliators, but also many of our native insects which inhabit indigenous forests are now commencing to attack exotic species, and the potential danger from this source is an ever-increasing one. That up to the present we have concentrated entirely on attempts to preserve our plantations of exotic species from insect attack, can possibly be attributed to that very human trait of placing a greater value on the article for which we have had to put our hands in our pockets than on that which has been freely presented to us.

Also, no reference will be made to the major insect pests of the wattle, as these have been treated for many years as a separate problem to the general one of forest protection from insects.

Insects Attacking Eucalyptus Species.

There are only two insects of any importance attacking *Eucalyptus* species, both are introduced species of Australian origin, and both have become well established.

Gonipterus scutellatus

The first in importance is the eucalyptus snout-beetle, *Gonipterus scutellatus* Gyll. This insect was first discovered in Cape Town in 1916. It rapidly increased in numbers and spread throughout the gum-growing areas of the Union at an alarming rate. By 1924 its depredations had become so fearful that it menaced the whole industry. Various expedients were tried by the Division, such as winter cultivation, burning of coppice and dusting with an arsenical insecticide from aeroplanes. These methods proved to be either inefficient or too costly, and as a last resort a search was made in Australia for natural enemies. This search resulted in the discovery, introduction and establishment of a mymarid egg parasite, *Anaphoidea nitens* Gir., in 1927, with the result that economic control has been obtained over at least seventy-five per cent. of the infested area. The remaining twenty-five per cent. is situated mainly on the high plateaux, commonly known as the high veld, varying in elevation from 4,000 to 6,000 feet. During the past three years the improvement in the condition of plantations even in these areas has been so remarkable that eventual control of the pest over the whole infested area now appears assured.

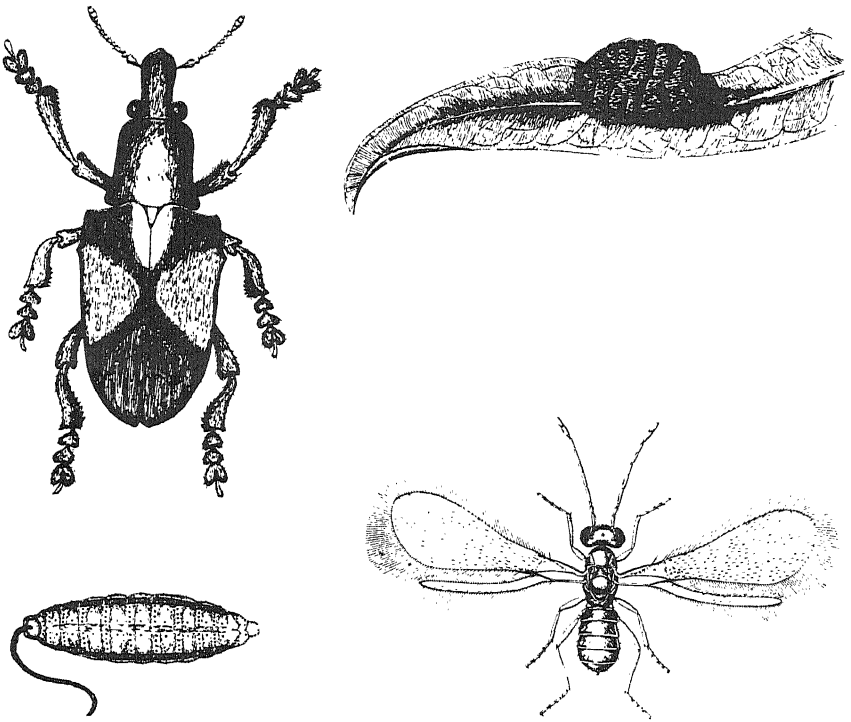
The length of time taken by the parasite to exercise any check on the ravages of its host in plantations in the highveld areas may be attributed to two main reasons. The more obvious is a definite modification in the life-history of the host in adapting itself to a climatic environment differing from that of its optimum natural habitat, whereas no corresponding change takes place in the life-cycle of the more specialised parasite. This results in a considerable reduction in the numbers of the latter during the winter months, with a subsequent lag in the spring months before its numbers have increased sufficiently to check the ravages of the pest.

The less obvious but probably equally important factor is lack of vigour in the trees. This lack of vigour may be attributed to poor and shallow soil, frost and deficient rainfall. It is believed that the host population has been and is being steadily reduced, but that prior to 1928, high veld conditions for both parasite development and tree growth favoured beetle increase at the expense of foliage output, with the result that almost complete defoliation took place. Due to the steady progress made by the parasite in reducing the numbers of the host, it is believed that we are now reaching the stage when the balance is swinging over to the credit side, particularly in plantations where conditions for tree growth are better than in their less fortunate neighbours. It must be emphasized, however, that this equilibrium is still very delicately poised and any such factor as drought and increasing competition as trees become bigger is sufficient to cause an apparent retrogression. Unless this hypothesis is correct, it is difficult to explain why single trees and windbreaks have been the first to show improvement, while plantations of the same species, less than a mile away, were still badly damaged. It is difficult to explain why one portion of a plantation of single species of eucalyptus should be flourishing and the other half eaten down, unless we can explain it by soil variation.

It is firmly believed that if the vigour of trees in plantations at present suffering severe damage could be improved by increased foliage output, the snout-beetle as a problem would cease to exist. The damage in many such plantations is more apparent than real, and the progress of control in the future may be greatly accelerated if more attention is paid to site selection.

Phoracantha semipunctata.

The cerambycid borer, *Phoracantha semipunctata* F., reached our shores about 1906. Observations show that although it does at times attack healthy trees, such an attack is the exception rather than the rule. In other words, the damage done by the insect is of a secondary nature, its attack being confined almost entirely to newly-felled timber from which the bark has not been removed, and sickly and dying trees. Wood once it is properly dry is seldom if ever attacked. It is clear that to prevent the insect ravaging them, eucalyptus trees in infested situations should be kept in a vigorous condition as far as practicable. Generally it is not practicable to do much towards improving the environment for the trees, but such measures as proper thinning and adequate fire protection, particularly in privately-owned plantations, can be given more attention. The greatest danger is drought. Obviously trees that would be proof against drought alone or *Phoracantha* alone



EUCALYPTUS SNOUT BEETLE (*Gonipterus scutellatus*).

Top left: Adult (× 5).

right: Egg mass (× 5).

Bottom left: Larva (× 6).

Mymarid egg parasite (× 22).



Effect of snout beetle and frost on stand of *Eucalyptus viminalis* at Delmas.



Recovery of stand of *Eucalyptus viminalis* at Modder B from snout beetle attack in response to liberation of introduced parasite.

are seriously menaced when they have to contend against drought and beetle together. While little can be done in keeping trees in a thrifty condition if planted in unsuitable areas, much can be done to keep down the numbers of beetles. The chief measures are use of trap trees, stripping the bark off freshly-felled timber, and prompt utilization of infected wood.

Insects Attacking Conifers.

Our conifers as yet are free from any serious introduced insects, our worst enemies being several species of indigenous lepidoptera which have adapted themselves very readily to their new diet.

Nudaurelia cytherea capensis.

At present the most important of these lepidoptera is the Pine Tree Emperor Moth (*Nudaurelia cytherea capensis* Stoll.), which causes rapid and often serious defoliation of *Pinus insignis* in the Cape Province. This large caterpillar was first reported as a pest in 1896. Its attacks at first were very sporadic, lasting for only two to three seasons at the most, and restricted to isolated plantations in various parts of the Province. Lately, however, attacks have lasted longer and the area of infestation is rapidly extending so that this insect must now be regarded as a serious menace. Despite experimental demonstration in 1926 that the destruction of pupae in the soil by pigs was by far the most efficient and economical control measure, growers have persisted in using the old-time measures of hand-picking the eggs and caterpillars and destruction of pupae by hand. Recent extensive experiments carried out for four seasons at Lebanon and French Hoek have confirmed the practicability, efficiency and economy of the use of pigs and shown that the several hand measures, while incurring considerable expenditure, are palliative rather than controlling. Even with greater efficiency in hand-picking methods over extended periods there is no guarantee of satisfactory control being established and, even if such control were attained, there would remain no form of insurance against a recurrence of the attack after the passing of two or three years.

Euproctis terminalis.

The pine brown-tail moth, *Euproctis terminalis* Walk., has far greater potentialities as a pest of pines than *Nudaurelia,* but up to the present it has caused serious defoliation at Jessievale plantation only. Prior to 1929, in which year two severe isolated outbreaks at Jessievale and Harrismith occurred, this insect was not known to attack pines. Since then, however, its presence has been detected in practically every pine plantation in the northern and north-eastern Transvaal. So far it has restricted its attack to *Pinus patula, P. leiophylla, P. insignis* and *P. pinaster,* preference being shown in the order given. As there are approximately 31,000 acres of the first-named species in Government forests alone in the abovementioned areas, the advent of this pest must be viewed with considerable apprehension.

There are two distinct biological strains of this Lymantriid: one at Jessievale where the caterpillars feed during the winter and spring months, and the other at Harrismith, Belfast and Berlin-Coetzeestroom

where the caterpillars are found during the summer months. At Sabie both strains have been found.

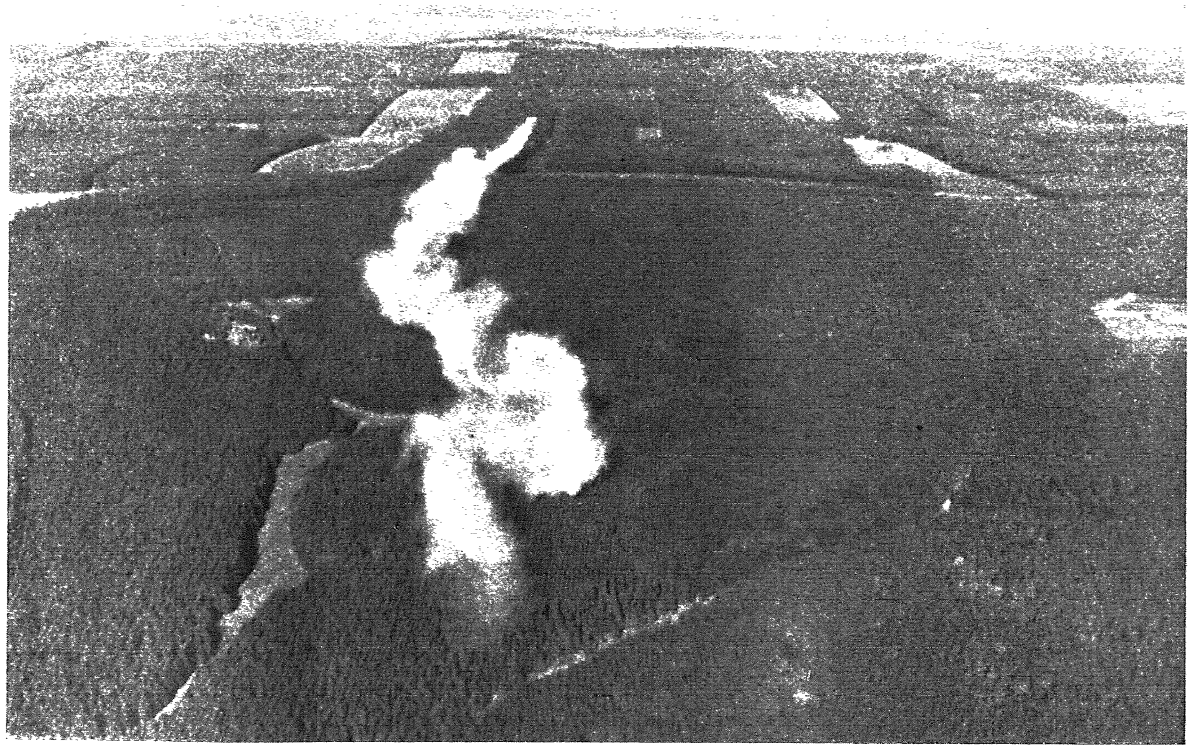
Up to the present, with the exception of Jessievale, outbreaks at all the abovementioned plantations have been of a very sporadic and restricted nature, accompanied by very little damage. At Jessievale, however, the infestation increased steadily in size and intensity until by 1936 almost every *P. patula* compartment, an area of 1,800 acres, was extremely heavily infested, and defoliation proceeded at an alarming rate. In order to prevent further material damage it was deemed necessary that some form of direct control should be provided. In view of the size of the area to be treated and the time available, the distribution of poison dusts over the infested plantation by means of aeroplanes seemed to offer more hope than any other as a method of direct control. Several difficulties had to be contended with at first. The only machines available were unsuitable. Weather conditions at the period when dusting was required were unfavourable. Great difficulties were experienced in marking the plots so that their boundaries could be clearly discerned by the pilot when flying low over the tree tops. In addition, trouble was experienced with uneven liberation of the dust from the hoppers in the machines. These difficulties were eventually surmounted and calcium arsenate dust was applied at a dosage of approximately 20 lbs. per acre with a fair degree of exactness. The results were excellent, a control of at least 93 per cent. being obtained, severe defoliation over practically the whole area prevented and the infestation reduced in the following season to only 370 acres. Subsequently, owing to non-availability of suitable aircraft and the comparatively small areas to be treated, ground dusting operations were put into force during the following four seasons. These were finally discontinued in 1941 as being uneconomical owing to the necessity of using high dosages, the very much heavier wastage as compared with aeroplane dusting and the much greater length of time taken to apply the insecticide.

Taking all things into consideration, as a result of four seasons' ground dusting at Jessievale, there seems little doubt that the application of poison dusts from the ground is not an economical and practical method for the control of pine defoliators. As a direct result of the experience gained in this work there has been a tendency to condemn the application of poison dusts from the air as well. Such a conclusion based on only one season's experimental dusting under most unfavourable conditions is unsound and it must be emphasized that the case for or against aeroplane dusting for forest defoliators is not yet proven. It must be remembered that this method has been employed with success for the control of other defoliating forest caterpillars in both the United States and Europe, that it has given practical and successful results against the wattle bagworm, *Acanthopsyche junodi,* in Natal, and that very excellent results were obtained at Jessievale.

Another point which may be overlooked is that defoliation of *P. patula,* a very vigorous grower, by the more destructive strain of *E. terminalis,* apart from affecting increment, does not appear to weaken the trees materially, as defoliation takes place during the dormant period and just before the rainy season. It may well be, however, that defoliation of this or other species of conifers at other times of the year by another species of defoliator may cause considerable loss and the rapid applica-



Stand of *Pinus patula* at Jessievale, Transvaal, defoliated by *Euproctis terminalis*.



Dusting *Euproctis*-infested *Pinus patula* with calcium arsenate from the air.

tion of an insecticide may be the only means of preventing this. In such a case dusting from the air would be the only feasible and practical method. Meanwhile, owing to the scarcity of insecticides and the impossibility of obtaining aircraft, an attempt is being made to control the pest by biological methods; that is, by introducing, from America, natural enemies of the American brown-tail moth, *Nygmia phaeorrhea* (*Euproctis chrysorrhea*).

Heliothrips haemorrhoidalis.

Another insect which at first caused considerable concern is the pine thrips (*Heliothrips haemorrhoidalis* Bouche), the common greenhouse thrips of Europe. This insect first appeared in 1930 in *P. patula* compartments in the Northern Transvaal. It appears to be of Central American origin but now has a world-wide distribution. It has an extremely large range of hosts but so far as is known there is only one other record of its attacking pines and that is its occurrence on *P. insignis* in New Zealand. In this country it has so far confined itself to *P. patula, P. leiophylla* and *P. insignis,* and with the preventive measures now evolved it cannot be classed as an insect of great economic importance. Under suitable conditions, however, particularly in neglected or unthrifty stands, it can increase and multiply tremendously, thereby causing a heavy and premature fall of needles, by sucking out moisture from the plant tissues.

It is a shade-loving species restricting its attack to the lower portion of the crown and the under surface of the branches. It is most prevalent in sub-tropical regions where the precipitation is heavy and it occurs in large numbers in densely-stocked and over-stocked stands where considerable suppression and great competition is taking place. Suppressed trees are often very severely attacked. Laboratory experiments have shown that it needs high humidities with medium temperatures for its optimum development and that it is extremely sensitive to the evaporative power of the atmosphere, rapid evaporation from the body surface speedily proving fatal. Thinning infested stands controls the pest almost immediately as by this operation the rate of evaporation in the areas concerned is increased and the insect rapidly disappears. This is a striking example of the control of a forest insect by purely silvicultural methods.

Forest Insects of Minor Importance.

Gonimbrasia tyrrhea.

The Willow-tree Caterpillar (*Gonimbrasia tyrrhea* Cram.) is a native saturniid which at times causes severe defoliation to pine, wattles and mimosa. Two seasons ago practically every wattle stand and all the mimosas (*Acacia* spp.) in the area between Idutywa and Port Elizabeth were completely stripped. A stand of *P. insignis* at Krakeel also suffered severely. Its life history and habits are similar to those of *Nudaurelia,* the moth closely resembling it in size, marking and form, and it can be controlled by the same methods.

Pachypasa capensis.

The caterpillars of the lasiocampid moth, *Pachypasa capensis* Aur., occasionally occur in enormous numbers on black wattle (*Acacia mollissima*) in the eastern Transvaal, causing severe defoliation. They also feed on pines, notably *P. patula,* but to a lesser extent. The caterpillars feed during the winter months and have the habit of congregating in large masses on the tree trunks. They pupate in November and the moths emerge the following February and March to oviposit. The caterpillars' habit of congregating in large clusters on the tree trunks makes it easy to destroy them. The most effective and economical method of doing this is to burn them off with Hauck torches. Extensive outbreaks usually disappear after two or three seasons as a result of the control exercised by parasites and disease.

Pachypasa albofasciata.

An extensive and heavy infestation of the Lasiocampid, *Pachypasa albofasciata,* Aur., has been reported on *P. insignis* at La Motte this season. This is the first appearance of this insect as a pest of pines. Its potentialities are unknown.

Taragama concolor.

Another native Lasiocampid which causes serious but, fortunately, sporadic defoliation of *P. insignis* plantations in the western Cape is *Taragama concolor* Walk. All past outbreaks have been so rapidly controlled by parasites and bacterial and fungous diseases that the development of control measures has not been necessary.

Teragra guttifera.

In recent years the native lepidopterous borer, *Teragra guttifera* Hmpsn., has made its appearance in *Populus deltoidea* stands in the Langkloof and Stutterheim districts of the Cape Province and in Natal. Its advent has caused much concern to match manufacturers and to poplar growers and it certainly has caused havoc in the unthrifty poplar stands in the Langkloof. The position in Natal is not so serious; in the most heavily infested stands only about five percent of the trees being attacked.

Combative measures at present advocated are removal and destruction of all badly infested trees and the tarring of pruning wounds and the entrances of the burrows. These measures have so far proved very successful in preventing increase in infestations.

Metarbela sticticosta.

The native lepidopterous borer, *Metarbela sticticosta* Hmpsn., is related to *T. guttifera.* It has caused severe damage to oak plantings in the eastern Transvaal. Only the fact that oaks are not grown on a large commericial scale prevents its being considered of serious economic importance.

Calosposoma acaciae.

The small, bright, metallic green or bronze Chrysomelid beetle, *Calosposoma acaciae* Bry., periodically causes serious damage to wattle

regeneration in the Hendriksdal area, eastern Transvaal. Damage is done by the beetle. The larvae spend their life underground feeding on humus and rootlets. Outbreaks appear to be connected with early spring rains; a fairly high soil moisture content apparently being necessary for the pupation and transformation of the insect. Fairly good control has been obtained by dusting the small wattle trees with pyrethrum or arsenical dusts. The latter are preferable as they retain their toxic properties for a longer period.

Odontionopa sericea.

Another small metallic green Chrysomelid beetle which often kills a high percentage of *P. insignis* transplants in the western Cape is *Odontionopa sericea* Gyll. Dusting with arsenicals has been recommended but no conclusive data are yet to hand.

Hylastes opacus.

Hylastes opacus, Er., is a well-known european bark-beetle which made its first appearance some years ago in the George district, where it was found commonly breeding under the bark of old stumps and logs in the plantation, but caused no injury to freshly-planted conifers as it invariably does on the Continent. This season it was reported from Belfast and Jessievale and in these plantations it caused considerable injury in newly-planted areas.

Two broods are produced in the year and bad soil conditions, frost damage, and bad planting predispose trees to attack by the beetle. Trapping is the only remedy so far devised, and billet traps of pine are recommended. The billets should be 2ft. to 3ft. long and 2ins. to 3ins. in diameter. For the egg-laying beetles, they should be laid in close contact with the ground, preferably in October and January and lifted in December and June respectively. Other traps can be kept going throughout the season to catch the feeding beetles.

Insects Attacking Timber.

Freshly-felled or Sawn Timber.

Damage by longicorns and buprestids is preventable by removal of bark, restricting felling to certain seasons, destruction of felling debris, early conversion and, where the supply permits, storage under water.

Damage by shot-hole and pin-hole borers, Ambrosia beetles (*Platypodidae*) may be greatly alleviated by prompt sawing followed by rapid conversion. Rapid seasoning is the most important aid in the control of these beetles. Kiln drying provides absolute protection and any method which will favour rapid seasoning, such as careful piling so as to provide good air circulation, barking and piling logs in open piles and sun curing will tend to minimise the danger of attack by these borers.

One of the best and most effective methods of preventing logs being attacked is by storing them in water, although the treatment does not give permanent immunity unless the logs are kept in water for a year or more.

Seasoned Timber.

The worst pests of sawmills and factories for boxes, veneers, plywood, planking, building timber, etc., in this country are the *Lyctus* powder-post beetles, which attack the sapwood of hardwoods. In addition, there are a large group of native *Bostrichid* beetles which attack both softwoods and hardwoods. With the former group we have to deal with a minimum life-cycle of seven months and with the latter group one year, but all species in this class continue to develop in infested wood for several years.

It is emphasized that realisation of the powers of spread of *Lyctus* beetles, particularly, and concerted action by all parties concerned, suppliers as well as users of the sapwood of susceptible hardwoods, are essential for the effective control of these beetles.

The following measures are recommended for the control of *Lyctus* beetles in timber yards and factories.

(1) Regular inspection at least twice per annum of timber stored in the open. In heated storage premises inspections should be more frequent. Susceptible timber entering the yard or factory should be given a thorough inspection.

(2) So far as practicable all sapwood should be removed. Even the removal of a portion of the sapwood, i.e., the outer portion which is more attractive to the beetles, is of considerable assistance in preventing attack.

(3) All infested material should be segregated and the infested sapwood removed and destroyed.

(4) Cleanliness in a yard or factory is of the utmost importance.

(5) Where piling sticks and cleats used in stacking are cut from hardwood species, all sapwood should be excluded.

(6) Sterilization by heat offers the best solution for the destruction of *Lyctus* in infested sapwood. As this treatment does not prevent re-infestation, sterilised stock should be utilized without delay or treated as indicated in (7b) below.

(7) On economic grounds, the use of insecticides or preservatives in timber yards is not generally recommended, but in these days when every effort should be made to conserve timber one of the following methods is suggested:

  (a) Full treatment in a metal salt or other suitable preservative of all boards containing sapwood.

  (b) Sterilization of boards containing sapwood followed by immediate use of surface preservative.

  (c) Dipping boards in a strong solution of zinc chloride before stacking for drying, followed by (7b) above.

In concluding this review of forest insect problems and the control of the insects concerned, the best advice that can be given forest officers, foresters and timber merchants is:

(1) Discover the outbreak or damage in its earliest stages and report promptly. Make an early decision whether and how to act.

(2) Apply preventative or control measures exactly as advised by the expert without modification by local exigencies and theories.

(3) Compile accurate data on the cost of any such measures so as to justify expenditure against hypothetical loss of capital.

THE VARIABILITY OF JONKERSHOEK STREAMS

By C. L. WICHT

(Forest Research Officer, Jonkershoek.)

THREE types of fluctuation occur in natural streams such as are being investigated at the Jonkershoek Forest Influences Research Station. Spates composed of storm-flow are caused by all rains strong enough to yield surface run-off. Long term fluctuations in ground-water flow are caused by the infiltration of rain-water, which increases the ground-water stored in the catchment, and by evapo-transpiration losses and flow of water out of the catchment area, which deplete the stored ground-water. Diurnal depressions in ground-water flow are caused by daily evapo-transpiration losses of moisture from the stream-bed. By plotting all such fluctuations in flow over time, a hydrograph reflecting the character of the stream during the period of observation is obtained. It is essential to analyse such hydrographs in order to demonstrate the effects of treatment applied in the catchment areas of the streams. In this paper the main features of characteristic annual hydrographs of Jonkershoek streams are examined and statistical measures of the variability of streamflow suggested.

Construction and Interpretation of Hydrographs

In the hydrographs reproduced in Figs. 1 and 2 the rates of flow in cubic feet per second (cusecs), taken at 6 a.m. and at the peak of each spate, were plotted. Minor fluctuations during spates, which could not be clearly shown on such small scale diagrams, were disregarded. Diurnal fluctuations due to evapo-transpiration losses have also been ignored. The flow at 6 a.m. on dry days represents about the highest level recorded on such days. If it is assumed that the evapo-transpiration losses causing diurnal fluctuations occur from ground-water, which has already seeped into the stream or its immediate vicinity, the dry weather flow sections of the hydrographs may be looked upon as representing the potential true ground-water flow. In Fig. 1 of a paper on diurnal fluctuations reproduced on page 35 of No. 7 of this Journal, a more detailed hydrograph showing such fluctuation was reproduced.

The black area in each diagram is approximately equivalent to the total annual discharge of the stream. All points shown represent spates made up of stormflow derived from surface run-off discharged into the streams during and for a short while after rain. A line drawn to cut off these points would separate stormflow and ground-water flow approximately. To effect this separation the ground-water depletion curve is frequently used (Horton '35, Wicht '42).

The hydrographs have been plotted for streamflow years. They commence with April, the month during which winter rains normally set in, and they end with March, which is usually the month of lowest flow. This ensures that most of the precipitation received during the

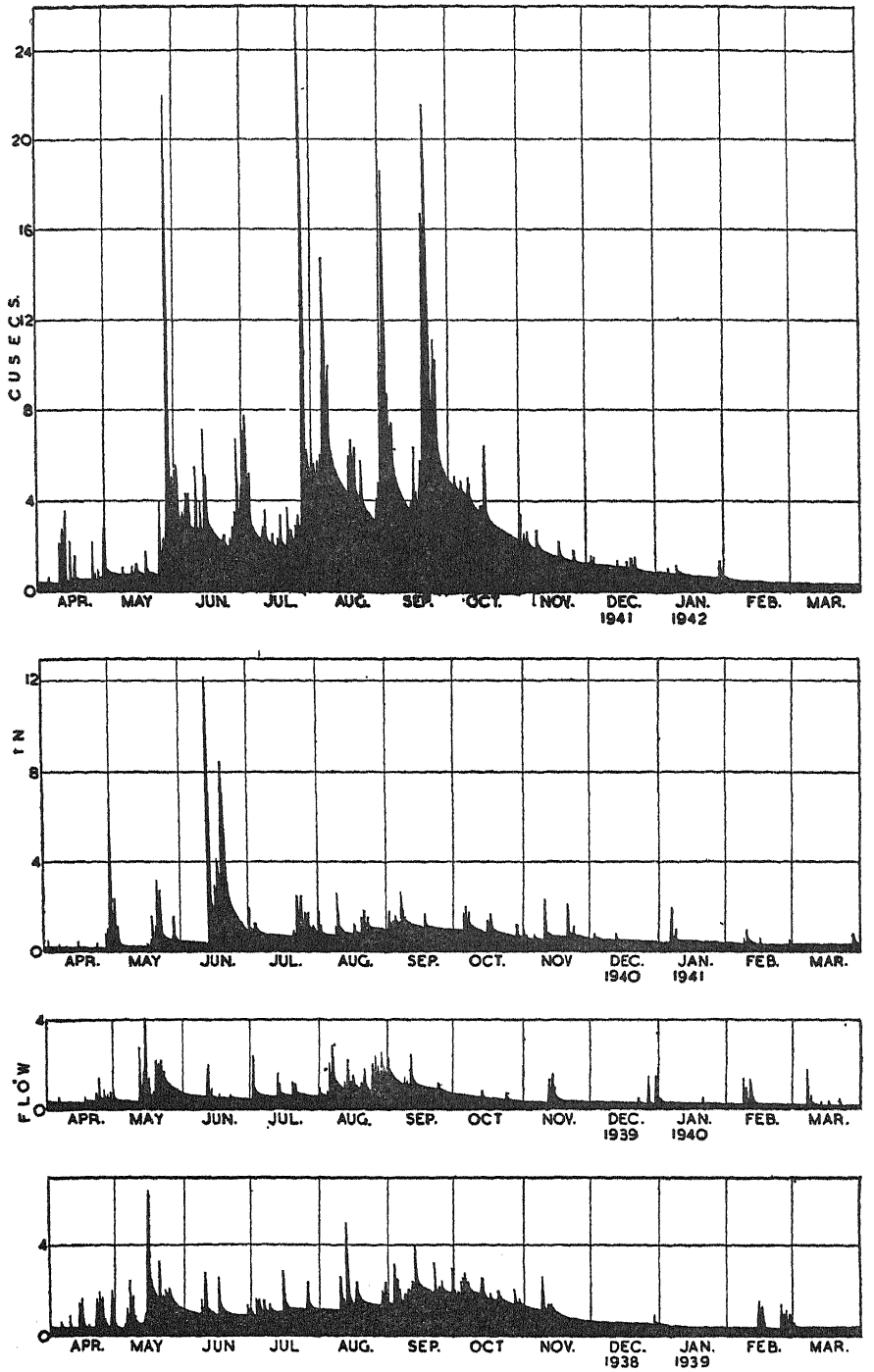


FIG. 1.—Hydrographs, Bosboukloof 1938-'42.

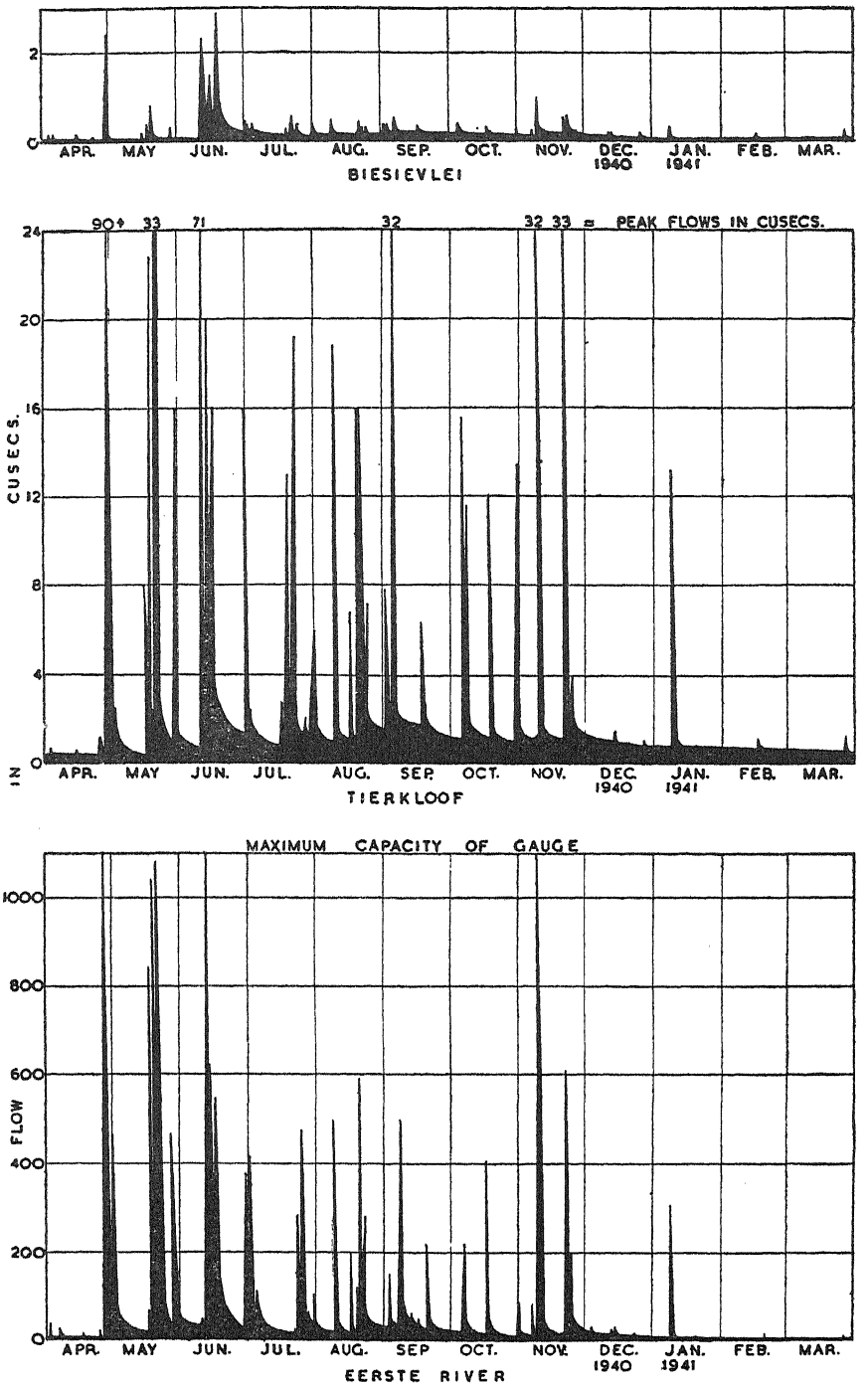


FIG. 2.—Hydrographs, Streamflow Year 1940-'41.

year is reflected in the streamflow of that year. Errors due to differences in discharge at the beginning and end of the observation year are thus reduced to approximately a minimum. In the analysis of data from the Wagon Wheel Gap experiment in Colorado similar streamflow years were used (Bates and Henry '28).

Fig. 1 shows that the total annual discharge from a stream may vary considerably from year to year. In all Jonkershoek streams this variation is closely correlated with the wetness of the years. Thus, raingauge No. 1, situated on the *Bosboukloof* stream, registered the amounts of total annual rainfall for the streamflow years, which are given in the table on page 19. The relative volumes of total annual discharge from this stream for these years can be judged from the hydrographs or read from the table. The reasons for the correlation are that the catchments are small, steep (Wicht '39) and, as shown in Figs. 1 and 2, the ground-water flow carried over from one year to the next is relatively low. Consequently, the effect of the rainy season on the ground-water flow is not so long delayed that the discharge in the succeeding year is markedly increased. A further reason for the close correlation is that, though there is a significant increase in precipitation with increase in altitude, the distribution on individual catchments is not irregularly variable.

If the hydrograph for *Bosboukloof* 1940-41 is compared with that of *Tierkloof* for the same year, which is drawn on the same scale, it will be seen that the *Tierkloof* stream responds much more strongly to rain. Most rains caused spates in both streams, but stormflow in *Tierkloof* was in each case much stronger. This is due to the much steeper nature of the catchment, which is surmounted by precipices rising to peaks over 5,000 feet high. The *Eerste River* hydrograph, drawn with scale of flow one-fiftieth of that for *Bosboukloof* and *Tierkloof*, shows that this stream is even more "flashy." It includes in its catchment the *Tierkloof* and other precipitous secondary catchments. The small, relatively flat, *Biesievlei* catchment—the flow scale of the hydrograph is twice that used for *Bosboukloof* and *Tierkloof*—yields a more steady stream.

Most of the spates occur in the winter months May to September. They are caused by typical rains from the north-west (Wicht '40). A rain on the 29th of April, 1940, caused a flood in the *Eerste River*, which, according to old inhabitants, was one of the severest ever experienced. Spates caused by this rain in *Bosboukloof*, *Biesievlei*, *Tierkloof* and *Eerste River* are shown in Figs. I and 2 (the spate in the *Eerste River* has, unfortunately, been plotted slightly out of its true position). Recording raingauge No. 14, situated slightly more than half-way up the *Eerste River* catchment, showed that at this point over three inches of rain were received from 1.15 to 2.15 p.m. A recorder situated about quarter-way up the catchment received 1·98 inches in this period of one hour. Rain was continuous before and after this time. These figures are probably under-estimates because the rain was accompanied by fairly strong wind and the gauges were not sheltered in any way. The peak of the flood in the *Eerste River* occurred at 3 p.m. and is illustrated in Plate 1, top. The Parshall Flume was completely submerged and the rate of flow was roughly estimated at about 5,000 cusecs. One hour later the water level had dropped three

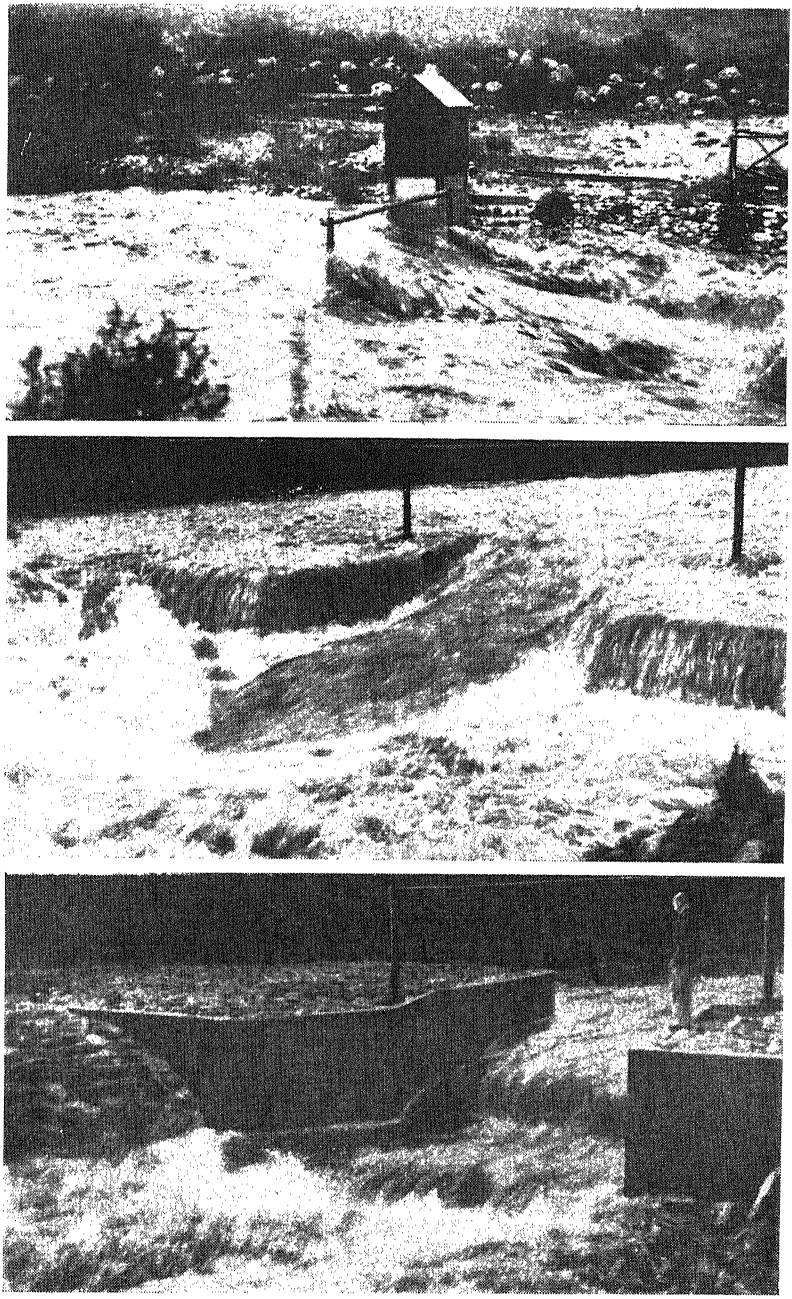


PLATE I.

Top.—Flood Peak over Parshall Flume in Eerste River on 29th April, 1940. Estimated flow 5,000 cusecs.

Middle.—Flood in Eerste River on 29th April, 1940, one hour after peak.

Bottom.—Flood in Eerste River on 30th April, 1940, 24 hours after peak. Estimated flow 143 cusecs.

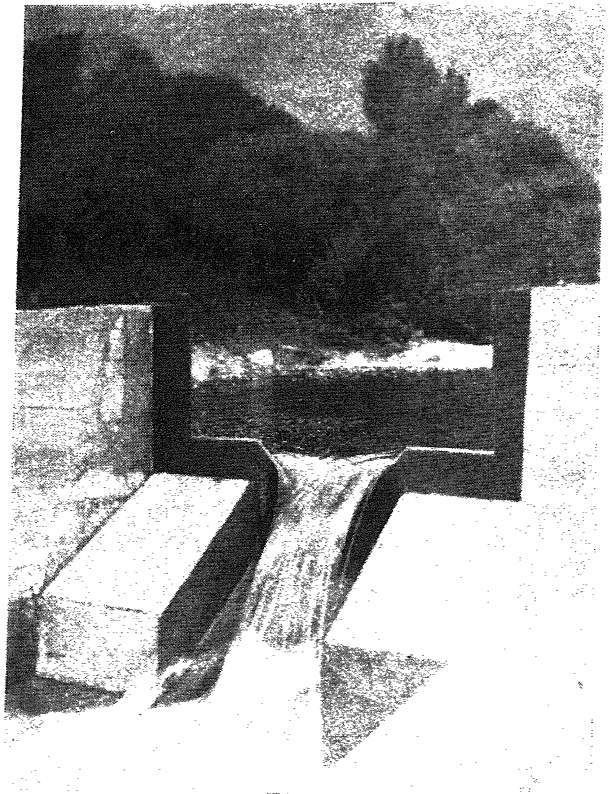


PLATE II.—Flow over *Tierkloof* Weir about 24 hours after peak flow on 29th April, 1940. Peak exceeded capacity of notch for one hour.

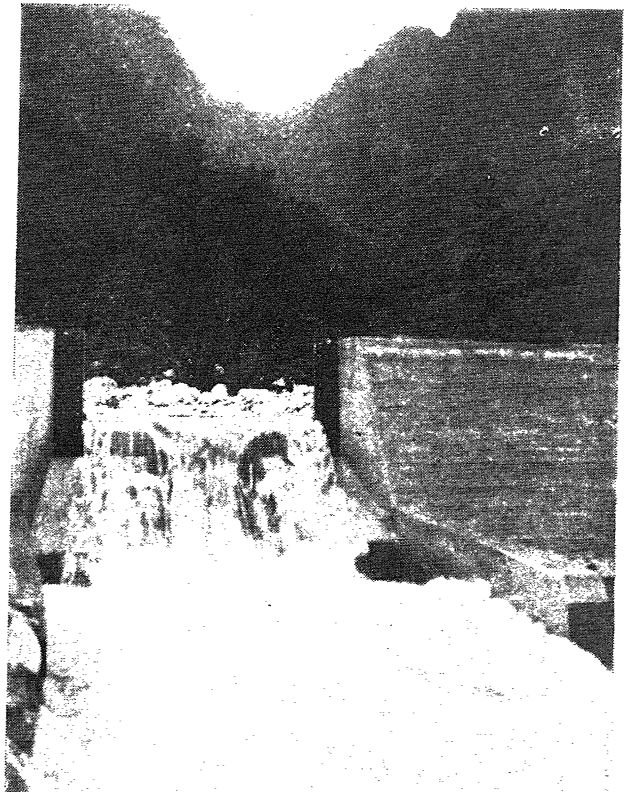


PLATE III.—Flow over *Langrivier* Weir about 24 hours after peak flow on 29th April, 1940. Peak greatly exceeded capacity of notch.

feet (Plate 1, middle). Twenty-four hours after the peak the flow was only 143 cusecs (Plate 1, bottom). At *Tierkloof* gauging station situated about 1,600 yards higher up the valley the peak flow occurred three-quarters of an hour earlier. The flow over the gauging weir in this stream approximately twenty-four hours after the peak of the flood is shown in Plate II. In Plate III flow over the *Langrivier* weir at about the same time is shown. (These two photographs show clearly the form and function of the compound weir notches used on all Jonkershoek streams except the *Eerste River*). The rain was apparently concentrated near the end of the valley towards the south-east. The spate in *Bosboukloof*, situated to the north-west, was therefore relatively weaker.

Small spates which occur in the summer months are also normally caused by occasional north-west rains. The rain from the south-east on the 9th of November, 1940, which caused strong spates in all streams, constitutes an exception, however. The spate caused by this rain in the *Eerste* River, the catchment of which extends far to the south-east, exceeded the capacity of the gauge by a considerable volume. In *Tierkloof* the spate was also relatively strong. In *Bosboukloof*, furthest to the north-west, the spate was relatively weak.

The considerable variations in streamflow caused by the differences in the wetness of the years and differences in the nature of the catchments, complicate the determination of the effect of various systems of catchment management on the flow. Unless the effect of treatment on, for example, the total annual discharge is very marked, observations over a very long series of years will be required to prove the significance of observed differences, if such differences can indeed be proved to be significant at all. In the Jonkershoek investigation an improvement is made if the regression of total annual discharge on total annual precipitation is used in experimental comparisons, because the portion of the variance due to differences in wetness of years can thereby be excluded (Fisher '36). Even this correlation may not be rigid enough to prove the significance of the smaller observed differences, however. We are, moreover, not only concerned with the total discharge of streams. Suitable statistics must also be found to test the significance of the effect of treatment on variability in flow of streams over a period, on stormflow, on stability of streams in dry periods, on distribution of flow over the year, etc. The solution of this problem can, it is believed, be achieved only by careful satistical analyses of hydrographs. Statistics, which might be used in the study of groundwater flow, have been suggested in previous papers (1941 and '42). Here statistical measures of the variability of the streamflow will be discussed. It is hoped that it will be possible to deal with statistics suitable for showing the effect of treatment on stormflow and other aspects of stream behaviour in future communications.

Statistical Measures of Variability in Streamflow

The annual, monthly, daily and hourly variations in streamflow are shown by the total annual, monthly, daily and hourly discharges of the streams. These totals are proportional to the mean rates of flow in cusecs for the respective periods. For this investigation of the

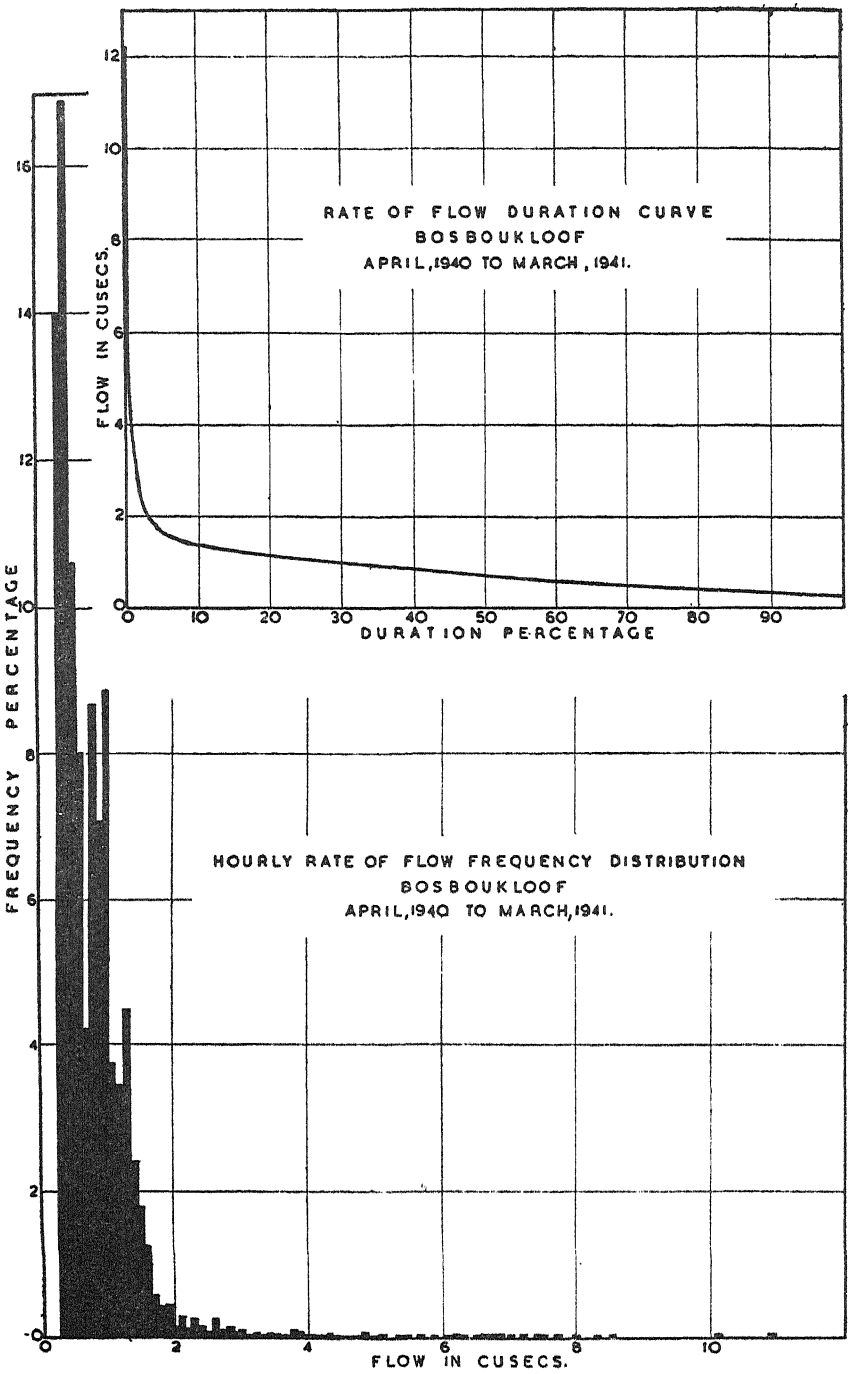


FIG. 3.—Frequency distribution and duration curve of flow, Bosboukloof. Streamflow year 1940-'41.

variability in Jonkershoek streams hourly readings of rate of flow have been used. Water level readings were taken from the recorder charts to the nearest hundredth of a foot. The flow was read from a table to the nearest tenth of a cusec. This method was considered sufficiently sensitive to evaluate the rapid rise and fall of the streams as shown in their hydrographs.

The first step in summarising the data was to sort them into hourly rate-of-flow frequency distributions for streamflow years. Such frequency-distributions incorporate all information in regard to rate-of-flow shown by the hydrographs. Flows are merely arranged in order of magnitude and not according to the time of their occurrence. The relative frequency-distribution for *Bosboukloof,* 1940-41, with frequencies expressed as percentages of the total number of hourly readings, has been represented as a histogram in Fig. 3. The general form of the distribution is clearly asymmetrical and strongly leptokurtic. The location of the distribution is given by the arithmetic mean rate-of-flow in cusecs, which is proportional to the total discharge of the stream for the year in question (see table).

The variability of the flow is indicated by the dispersion of observations about the mean, a suitable numerical measure of which is the *standard deviation* (σ). As absolute measure of dispersion, Pearson's *coefficient of variation* (v) may be used. This is obtained by dividing the standard deviation by the mean and multiplying by 100. These measures of variability apply not only to distributions of the "normal" type; they are equally applicable to asymmetirical distributions like those being dealt wth here, and may be used to compare one distribution with another as long as the shape remains the same (Tippett '31). Values of σ and v are given in the table.

STREAMFLOW STATISTICS DERIVED FROM ANNUAL HYDROGRAPHS.

Stream.	Streamflow Year April-March.	Rainfall Inches.	Total Annual Discharge Millions of gal.	Statistics from Frequency Distributions of Flow.		
				Mean Flow cusecs.	Standard Deviation σ $\pm$	Coeff. of Variation v $\pm$
Bosboukloof	1938-39	42·85	204	1·04	·540	52·15
	1939-40	37·52	130	·66	·373	56·13
	1940-41	39·19	161	·82	·678	83·00
	1941-42	50·24	452	2·30	2·032	88·30
Biesievlei	1940-41		37	·19	·159	84·25
	1941-42		59	·30	·284	94·19
Tierkloof	1940-41*		327	1·66	2·943	176·77
	1941-42*		630	3·21	4·295	133·49
Eerste River	1940-41†		7,905	40·25	82·631	205·29
	1941-42‡		14,975	76·25	131·634	172·63
Abdolskloof	1941-42		16	·08	·048	56·33

*Maximum capacity of gauge exceeded for one hour.
†Maximum capacity of gauge exceeded for seven hours.
‡Maximum capacity of gauge exceeded for forty hours.

The values of v for the years 1940-41 and 1941-42 clearly show the differences in variability of the various streams. The provisional conclusions reached after examination of the hydrographs in Figs. 1 and 2 are now supported by the numerical measures of variability. The estimations for the *Tierkloof* stream and the *Eerste River* are, unfortunately, too low, because the gauging installations could not cope with the highest peak flows. For *Tierkloof* the errors cannot be serious, because in each of the two years for which observations are available only one reading is missing. The *Eerste River* exceeded the capacity of the Parshall flume for seven hours in 1940-41 and for forty hours in the stormy year 1941-42, however. In spite of this, the river still shows greater variability than any of its tributaries, which have so far been gauged. The variable nature of the river was recognised before any observations were made and peak flows greatly exceeding 1,120 cusecs—the approximate maximum capacity of the fifteen feet Parshall flume—were expected.

Values of v for *Bosboukloof* and *Biesievlei* indicate a possible slight correlation with wetness of the years. This is to be expected, because wet years are normally characterised by more frequent and intense rains, which cause more frequent and intense spates, and so increase the variability of the flow. For the *Tierkloof* stream and the *Eerste River*, in which very strong spates occur, the variability in the very wet stormy year 1941-42 is lower, however, than in the drier year 1940-41. This is probably due to the combined effect of two circumstances. In the first place a considerable part of the discharge of these streams is in the form of stormflow even in dry years, so that they are always highly variable. In wet years the variability is therefore less likely to be increased. In the second place, the frequent, strong spates in 1941-42 showed a tendency to run into one another in these streams. The full variation which could have been caused by each rain was therefore often arrested before it could show in the stream; or, in other words, the depletion of stormflow was frequently interrupted by the rise of the succeeding spate before ground-water flow level was reached, and the general variability of flow was thus reduced. Because the correlation between the wetness of years and the variability of streamflow is disturbed in this way, it becomes more difficult to determine the effect of treatment on the variability of the streams. If, instead of the total annual rainfall, a measure of the variability of rainfall were used, a stronger correlation with variability of streamflow might be obtained. Such a correlation would be useful in determining the effect of treatment and it is hoped that an opportunity will be found to investigate it.

The claim that forest cover in a stream-catchment tends to equalise the flow of the stream throughout the year has frequently been put forward. One of the deductions made from the investigations at Emmental, Switzerland (Egler '19); Burger '34) and at Wagon Wheel Gap, Colorado, United States of America (Bates and Henry '28), was that forest cover tended to decrease peak flows and increase ground-water flow. This was thought to be due to the fact that forests promote infiltration and retard run-off. A re-analysis of the Wagon Wheel Gap data by Hoyt and Troxell has, however, thrown some doubt on this conclusion (Hoyt and Troxell '34). They claim that forests reduce low flows as well as peak flows, but this does not imply that variability

is affected. The solution to the question of the effect of forests on variability should be provided by the comparison of values of v before and after treatment. If afforestation with exotic pine trees at Jonkershoek has a stabilizing effect on streamflow or otherwise, this should, therefore, be reflected in significant differences in the coefficients of variation caused by treatment. The effect of forests on minimum and peak flows should be investigated separately.

The "flow duration" curve (Schaffernak '35), frequently used by hydraulic engineers, may be deduced from the frequency distribution of flow. It is the summation curve obtained by adding all frequencies starting with the highest flow values, and plotting the successive totals. The curve can easily be smoothed. If the frequencies are given in percentages, a relative duration curve, such as has been reproduced in Fig. 3, is obtained. From this figure the relative duration of rate-of-flow greater than any given value can be read. The percentages may also be looked upon as "probability integrals" (Tippett '31), which give the proportion of readings lying above any given value. In demonstrating the effects of catchment treatments on streamflow such curves may be useful, because they give a simple general picture of variability of flow during the period for which they have been drawn.

Saville and Watson ('33) have plotted duration curves with the flow expressed as ratio of the mean run-off, and found that the form of curves was not affected by the size of the mean, provided the distribution of individual readings about the mean was similar. Duration curves of this type will, therefore, be similar for all streams that show similar dispersion, asymmetry and kurtosis in their frequency distributions. Morgan ('36) has shown that the "distribution of the individual flows with relation to the mean is affected by topography, arrangement of tributaries with regard to time of concentration of surface flow, geologic structure, soil, vegetation, weather, and human developments related to flow of water." The effects of these conditions are equally well shown by the form of frequency distributions, and in statistical analyses of streamflow in experimental hydrology the duration curves recommended by Saville and Watson offer no great advantages, though they may be useful to hydraulic engineers.

Summary

The paper deals with the main features of characteristic hydrographs of Jonkershoek streams which have been plotted for streamflow years. It is noted that the total discharge of streams varies greatly from year to year, and that this is correlated with the wetness of the years. Special attention is paid to variability of the flow from one year to the next, and from one stream to another. From hourly readings of the rate-of-flow, frequency distributions are compiled. The "standard deviations" and "coefficients of variation" calculated from these are suggested as suitable numerical measures of streamflow variability. The derivation and value of "flow-duration curves" are briefly discussed.

REFERENCES

BATES, C. G. and HENRY, A. J.: Forests and Stream-flow Experiment at Wagon Wheel Gap, Colorado. *Monthly Weather Review, Suppl.* No. 30, 1928.

BURGER, H.: Einfluss des Waldes auf den Stand der Gewässer. II. Mitteilung. Des Wasserhaushalt im Sperbel- und Rappengraben von 1915-16 bis 1926-27. *Mitt.d.Schweiz. Anstalt f.d. forst. Versuchswesen.* 18: No. 2 —311-416. Zürich, 1934.

ENGLER, A.: Einfluss des Waldes auf den Stand der Gewässer. *Mittl. d. Schweiz. Anstalt f.d. forst. Versuchswesen.* 12: Zürich, 1919.

FISHER, R. A.: Statistical Methods for Research Workers. Oliver and Boyd. London. 1936.

HORTON, R. E.: Surface Run-off Phenomena. Part I. Analysis of the Hydrograph. Publ. No. 101. Horton Hydrological Laboratory. Voorheesville, New York. 1935.

HOYT, W. G. and TROXell, H. C.: Forests and Streamflow. Reprint from *Trans. of American Soc. of Civil Engineers* 99:1958. 1934.

MORGAN, J. H.: Flow-duration Characteristics of Illinois Streams. *Trans. Am. Geophys. Union* 17th Annual Meeting. p. 418. 1936.

SAVILLE T., and WATSON, J. D.: An Investigation of the Flow-duration Characteristics of North Carolina Streams. *Trans. Am. Geophys. Union* 14th Annual Meeting. p. 406. 1938.

SCHAFFERNAK, F.: Hydrographie. Julius Springer. Vienna. 1935.

TIPPETT, L. H. C.: The Methods of Statistics. Williams and Norgate, London. 1931.

WICHT, C. L.: Forest Influences Research Technique at Jonkershoek. *Jour. of the S.A. For. Assoc.* 3:65-80. 1939.

————: A Preliminary Account of Rainfall in Jonkershoek. *Trans. of the Royal Soc. of S.A.* 28:161-173. 1940.

————: Diurnal Fluctuations in Jonkershoek Streams due to Evaporation and Transpiration. *Jour. of the S.A. For. Assoc.* 7:34-49. 1941.

————: Depletion of Ground-water Flow in Jonkershoek Streams. *Jour. of the S.A. For. Assoc.* 8:50-63. 1942.

NOMENCLATURE OF THE SOUTH AFRICAN YELLOWWOODS

INTRODUCTION

WITH NOTES ON DISTRIBUTION

BY J. J. KOTZE

(Conservator of Forests, Cape Town.)

NOMENCLATURE

GREAT apprehension was felt by South African Forest Officers some 22 years ago concerning certain proposed changes in the names of the principal South African species of the genus *Podocarpus*.

In the interests of science, botanical nomenclature is governed by certain internationally agreed conventions. Names of plants conferred before those conventions were inaugurated have occasionally to be revised to conform thereto. As a rule such revisions are accepted without demur, but in the case of plants of economic value, such as timber trees, it is natural that disturbing confusion may be apprehended. As such confusion attended the revision of the *Podocarpaceæ* and in some quarters seems still to exist, the following notes, which provide a striking example of the complexities of botanical nomenclature, have been penned with the aim of dispelling it.

About 1920, in the course of a revision of this widely distributed genus, the late Dr. O. Stapf, then of Kew, proposed changing the botanical names of the South African species as follows:

Podocarpus Thunbergii Hook. to *P. latifolius* (Thunb.) R. Br. *ex* Mirb.
P. Thunbergii var. *angustifolia* Sim. to *P. elongatus* (Dryand.) L'Herit. *ex* Pers.
P. falcata (*P. Thunbergii* var. *falcata* Sim.) to *P. Henkelii* Stapf *ex* Dall. & Jacks.
P. elongata Carr. *p.p.* (*non* L'Herit. *ex* Pers.) to *P. falcatus* (Thunb.) R.Br. *ex* Mirb.

These proposals were naturally viewed with alarm by the Union Forestry Department and a vigorous protest was made to Kew. Lengthy correspondence ensued with negative results. In 1929, when the British Association for the Advancement of Science held its annual session in South Africa, the Chief Conservator of Forests secured the co-operation of several of the botanists and foresters attending the meeting in the passing of a recommendation to the International Botanical Congress to be held at Cambridge in 1930 to the effect that the current Latin names of our yellowwoods be specially conserved. In transmitting the recommendation he wrote:

> As an example we cite the names of certain species of *Podocarpus* indigenous to South Africa which, under the existing rules, are invalid for the trees to which they are now applied but which have been in use in South African botanical literature for periods up to about a century or more. Furthermore,

they have been employed in the official records and publications of the South African Forest Department, including its published Notices of Reserved Trees, annual reports, annual registers of yields and other scientific and technical records, ever since the Department was established. The trees are timber trees of commercial importance and the Latin names are known to the timber merchants and even to some of the sawyers and Native Forest Guards.

According to the existing Rules, certain of the names would even have to be transferred from one species to another, and thus the confusion in the scientific records and administration of the Department which would be caused by any change, would be very greatly increased.

The recommendation was sympathetically reviewed by the British Sub-committee on Nomenclature by whom a very limited list of *nomina specifica conservanda* had already been prepared for authorization by the Conference, to which the names of the four *Podocarpus* species were added. The list was, however, rejected, and in the second part of this article the arguments of the Sub-committee in connexion with these species are set forth by Mr. C. A. Smith, at that time South African botanist at Kew, who attended the Conference and who at the request of the Sub-committee investigated the Forest Department's recommendation.

Dr. Stapf's account of the South African *Podocarpaceæ* was included, and the new nomenclature adopted, in a supplemental part, Volume V, Section 2 (Supplement), of the "Flora Capensis" published in 1933, in view of which the Department could not do otherwise than accept the position and adopt the new names, however inconvenient it then was.

The advisability of refusing, as a Department, to adopt the new nomenclature was fully considered but was rejected as being a very narrow view and a retrograde step to take. The case had been comprehensively put to, and sympathetically considered by, the botanical authorities, and it was finally decided to accept their ruling.

In so far as the use of the existing common names was concerned, the only difficulty was in connection with the name "falcate yellowwood" for *P. Henkelii* Stapf. That name it was proposed to drop in view of inevitable confusion with *P. falcatus* (Thunb.) R.Br. *ex* Mirb, but no definite action was taken. No doubt the matter will receive attention by the South African Standards Institution in the compilation of a list of Standard Names for South African Timbers which it now has under consideration. I suggest the name "East Griqualand Yellowwood" as probably the most appropriate, notwithstanding the fact that it also occurs across the border in Natal.

Full particulars of the revision are scheduled below:

Botanical Name		Common Name
Present	Former	
P. latifolius (Thunb.) R.Br. *ex* Mirb.	*P. Thunbergii* Hook.	Upright or real Yellowwood.
P. elongatus (Dryand.) L'Herit. *ex* pers.	*P. Thunbergii* var. *angustifolia* Sim	Breede River or Western Yellowwood.
P. Henkelii Stapf. *ex* Dall. & Jacks.	*P. falcata* (*P. Thunbergii* var *falcata* Sim).	East Griqualand Yellowwood.
P. falcatus (Thunb.) R.Br. *ex* Mirb.	*P. elongata* Carr. *p.p.* (*non* L'Herit. *ex* Pers).	Common or Outeniqua Yellowwood, Kalander

Notes on Distribution

Further points of interest brought out in Dr. Stapf's account of the Yellowwoods are the following:

Distribution, etc., of P. elongatus (*Dryand.*) *L'Herit.* ex *Pers.*

The best known examples of this species are probably the bushy trees on the islands and banks of the Breede River near Robertson, but the tree also occurs in the Cedarberg, Clanwilliam Division, and at Michell's Pass, Ceres Division, while additional localities given in the "Flora Capensis" are Swellendam Division; River Zonderend; Stellenbosch Division; Malmesbury Division; Riebeckkasteel; Vlermuis Drift; Paarl Division; Worcester Division; du Toit's Kloof and Piquetberg Division.

This is the Western tree as distinct from the Eastern, *P. falcatus* (Thunb.) R. Br. *ex* Mirb. [*P. elongata* Carr. *p.p.* (*non* L'Herit. *ex* Pers.)]. Its size is given as from "'small' to 80 feet high," but I have never myself seen specimens as tall as that.

Reputed occurrence of P. Henkelii *in the Transvaal.*

Both Dr. Burtt-Davy in Part I of his "Manual of Flowering Plants and Ferns of the Transvaal" and Dr. Stapf record this species from the mistbelt forests of the Pietersburg District (Nelson No. 420) and from Barberton (Legat No. 3467). The latter specimen (*ex* National Herb. Pretoria) consists of *foliage only* and was collected by Mr. C. E. Legat in August, 1904. As far as he in 1926 could recollect, he must have gathered it in one of the creeks near Barberton. Its foliage resembles that of *P. latifolius* (Thunb.) R. Br. *ex* Mirb. (*P. Thunbergii* Hook.) so closely that its recorded identity should be accepted with some reserve.

The Division's Herbarium contains no material of this species from the Transvaal and it is distinctly doubtful whether it does occur in that Province. Information on the point, supported by fertile herbarium specimens, would be most interesting.

Reputed occurrence of P. gracilior *Pilger and* P. gracillimus *Stapf in the Transvaal.*

Both Burtt-Davy and Stapf record these species as occurring in the Transvaal. They resemble *P. falcatus* (Thunb.) R. Br. *ex* Mirb. [*P. elongata* Carr. *p.p.* (*non* L'Herit. *ex* Pers.)] very closely and are distinguished mainly by their very narrow leaves. Trees with very narrow leaves certainly occur in the Woodbush and Mariepskop forests but, as a wide range of variation in the foliage of *P. falcatus* according to age and position in the tree is well known, the narrow-leaved "Woodbush and Mariepskop trees have always been regarded merely as forms of the ordinary *P. falcatus* which also occurs there, or at best as geographical sub-species or varieties of the species. Stapf himself admits this and, although listing them as separate species, himself throws a great deal of doubt on his determinations which seem to have been based on altogether too few and incomplete specimens. In the circumstances, and until the point is clarified, it would be best to regard these narrow-leaved Transvaal trees as merely forms of the common *P. falcatus* (Thunb.) R. Br. *ex* Mirb.

NOMENCLATURE OF *PODOCARPUS* SPECIES

By C. A. SMITH

(Editor, The Farmer, *Pietermaritzburg.)*

At the International Botanical Conference held at Cambridge (England) in 1930, one of the principles unanimously adopted was the "Rule of Priority," i.e., that the oldest validly published legitimate name of a plant, whether described at the time of publication under the accepted generic name or not, must be adopted by all botanical workers [e.g., *Ptaeroxylon utile* Eckl. & Zeyh. (1837) must be rejected in favour of *P. obliquum* (Thunb.) Radlk., the plant having been originally described as *Rhus obliquum* by Thunberg in 1794], unless such a transference of a name from one genus to another would bring about a duplication in the latter genus. It was recognised, however, as had been done ever since the Vienna Conference in 1905, that certain widely used generic names which have been adopted in many floras, monographs, forestry and other relevant literature, would have to fall into disuse and other less well known or otherwise obscure equivalent names would have to take their places if the above "Rule" were rigorously applied, thereby leading to a considerable number of undesirable name changes, unless such generic names had not been "legitimised" or "conserved" by common censent of the various Congresses, e.g.:

Copaifera Linn. (1762) would be supplanted by *Copaiba* Mill. (1759).
Combretum Linn (1758) would be supplanted by *Grislea* Linn. (1753).
Olinia Thunb. (1799) would be supplanted by *Plectronia* Linn. (1767).
Dichrostachys W. & A. (1834) would be supplanted by *Cailliea* (Guill. & Perr.) (1833).
Hartogia Linn. f. (1781) in *Celastraceae* would be supplanted by a totally new name since it duplicates (i.e., is a later homonym of) *Hartogia* Linn. (1753), which would have to be resurrected after long desuetude to replace the later *Adenandra* Willd., a very well-known genus of *Rutaceae;* etc., etc.

In view of such eventualities the principle of the conservation of generic names (*Nomina Generica Conservanda*) against their earlier but obscure equivalents, is to-day generally welcomed, and it was felt that a great service would be rendered by extending the principle to cover the case of a LIMITED number of *species* of important economic, generally cultivated and universally known, plants such as the rice plant, the pine-apple, *Welwitschia,* etc. (about a dozen in all), the specific names of which would be "upset" by thorough application of the Rule of Priority.

It was in view of this that the motion of the Union Forestry Department relating to the four species of *Podocarpus* was sympathetically reviewed by the British Sub-Committee (whose duty it was to scrutinise and investigate all proposals to be dealt with by the 1930 Conference), and they were prepared to make concessions *in the event of acceptance* of the principle of conservation of specific names by the Conference. Briefly, the Sub-Committee argued as follows in regard to the four four species of *Podocarpus*:

(1) *P. Thunbergii* Hook. *vs.* **P. latifolius** (*Thunb.*) *R. Br.* ex *Mirb.* [= *Taxus latifolius* Thunb.].

P. Thunbergii Hook. is an invalid name since it is antedated by an earlier homonym for an Oriental species. Retention of the name would, therefore, violate the rule that all later homonyms are illegitimate under International Rules. In the event of the principle above cited being adopted, this homonymity would not prove such a serious obstacle, but adoption or retention of *P. Thunbergii* Hook. for South African species would (or could) entail a change in the name of the Oriental plant, and South African botanists and foresters could hardly maintain such a selfish view as to desire this with any degree of credit, the more so since there was the valid and correct name *P. latifolius* (Thunb.) R. Br. *ex* Mirb. available for the South African species. This latter name must, therefore, be adopted.

(2) *P. elongata* Carr. *pro parte* (*non* L'Her. *ex* Pers.) *vs.* **P. falcatus** (*Thunb.*) *R. Br.* ex *Mirb.* [= *Taxus falcatus* Thunb., *P. Meyerianus* Endl.].

One of the underlying arguments in favour of the conservation of certain generic names is that it prevents the resuscitation of such names in other families (see the case of *Hartogia* above cited). The same principle would similarly apply *mutatis mutandis* in the case of specific names. Yet in the case under review it was proposed that a later homonym *P. elongata* Carr. (*p.p.*) should be conserved against the quite valid and earlier homonym *P. elongatus* (Dryand.) L'Her. *ex* Pers. belonging to quite a different species—actually the one on which the genus was established, i.e., the type of the generic name *Podocarpus*. Moreover, since *"P. elongata* Carr." is *partly P. falcatus* (Thunb.) R. Br. *ex* Mirb. and *partly* the *original P. elongatus* L'Her. *ex* Pers., the adoption of *"P. elongata* Carr. (*p.p.*)" can only create a possible source of confusion and error which must be avoided. *P. falcatus* (Thunb.) R. Br. *ex* Mirb. should, therefore, be used for this species.

(3) A new combination based on *P. Thunbergii* var. *falcata* Sim, with *falcata* as the specific epithet, *vs.* **P. Henkelii** *Stapf.*

In as much as the prior homonym *P. falcatus* (Thunb.) R. Br. *ex* Mirb. already exists as a valid name for another South African species, the making of a new combination duplicating this name is in direct opposition to the rule relating to homonyms emphasised above. Stapf was, therefore, strictly correct in assigning a new name, *P. Henkelii,* to the varietal form when this was elevated to specific rank. (In this connection it should be noted that there exists no rule which makes it obligatory for an author to use the varietal epithet [in this case *falcata*] as a specific epithet in raising a particular variety to specific rank, though this is commonly done, except, of course, where a later homonym would result, as in the case under notice.) *P. Henkelii* Stapf *ex* Dall. & Jacks. is thus the correct name for the species.

(4) A new combination based on *Taxus capensis* Lam. *vs.* **P. elongatus** (*Dryand.*) *L'Her.* ex *Pers.* [= *Taxus elongatus* Dryand., *P. Thunbergii* var. *angustifolia* Sim.].

Taxus elongatus Dryand. (1789) long antedates *T. capensis* Lam., so that the name for the species in question must, under the Rule of Priority, be based on the former, hence *P. elongatus* (Dryand.) L'Her. *ex* Pers. becomes the accepted name and a new combination is wholly superfluous.

Even if the nomenclatural difficulties advanced under (1) and (2) could be overcome, in which case those under (3) and (4) also disappear, the final blow towards ever obtaining permanency for the four proposed names on a list of *Nomina Specifica Conservanda* was dealt by the almost unanimous vote of the Conference AGAINST extending the principle to specific names. As the Rapporteur of the Conference remarked: "The application of the principle to specific names would by its very nature render the work far more complicated than it is in actual practice."

It should further be noted that continued use of illegitimate names by one section of workers complicates the situation not only for other workers in the same country, but also for those in other countries, since it militates against the correlation and classification of information ascertained in the various branches of botanical science with the end in view of building up a complete whole—the essence of all Science.

SOME WEST AFRICAN SUBSTITUTES FOR WELL-KNOWN TIMBERS

By M. H. SCOTT

(*Chief Forest Products Officer.*)

At the outbreak of war imports of timber into the Union amounted to approximately 30,000,000 cu. ft. of sawn softwoods and 3,000,000 cu. ft. of hardwoods. The former were obtained mainly from Europe and North America and the latter from Europe, North America, India, the Philippines, Dutch East Indies, Australia and Japan. Although the South African market was comparatively small, with so many different sources of supply, prices were keen, and the consumer was able to select species and grades to meet his exact requirements. Comparatively little interest at that time was aroused by small quantities of tropical woods appearing on the market from other parts of Africa, which, with the exception of one or two species such as Okoume and the mahoganies, were almost unknown.

Outbreak of war and the spreading of hostilities closed most of the country's accustomed sources of supply entirely and heavily reduced supplies from occasional sources. Increased interest in nearer sources resulted, Rhodesia, Portuguese territory and more particularly the Belgian Congo being heavily drawn upon. Supplies of sawn timber from the last-named territory leapt from 7,000 cubic feet in 1938 to 600,000 in 1941, the latter figure being exceeded within the first five months of 1942. French Equatorial Africa and Nigeria also contributed as far as shipping would allow.

As a result of these changes and for other reasons the Government decided to send a small Survey Committee of four members to examine the position with regard to trade in general with the West African territories. As the member of this committee most concerned with timber supplies, the writer had an opportunity of investigating the position at first hand and was able to collect much data not elsewhere available.

Transport and Conversion

Most of the sawn timber and round logs from the Belgian Congo is shipped from Boma, a river port near the mouth of the Congo River. Shortage of ocean transport necessitates conveyance in river steamers and barges of considerable quantities of timber up to Matadi, a distance of about 45 miles. Here they are loaded into trucks and railed to Leopoldville 250 miles further up the river, rapids and strong currents making it unnavigable between these two points. At Leopoldville transhipment is made to barges which commence a ten day journey upstream to Port Francqui where the timber is loaded on to the railway for its final journey of some 2,700 miles to the Union. There are other sources of supply in the Belgian Congo from which transport is less complicated but from the commercial point of view most of them are less attractive.

Supplies from French Equatorial Africa are shipped direct from Pointe Noire in the South, Libreville and Port Gentil in Gaboon and Douala in the Cameroons. The main Nigerian ports for lumber are Lagos and Port Harcourt.

Although in some areas the method of handling logs is still somewhat primitive, the work is done on the whole in an efficient and up-to-date manner. Tractors convey the logs to central depots whence they are transported by rail, river or motor to the mills. As much use as possible is made of rafts in otherwise inaccessible areas. Rafts are made up of logs, two floaters to each sinker, bound together by creepers from the forest, which travel in long trains of a hundred or more on which the native workers, much like the teak workers on the Irrawaddy, build small huts. In these they pass several weeks as the current carries them down stream often for hundreds of miles.

Frame or band saws are used exclusively for breaking down the rough logs and they are also used for re-sawing in most cases. Some of the larger mills have as many as five or six large frame or band saws. Circular saws were conspicuous by their absence and where seen were used only for cross cutting or dimension cutting. The output from the more important mills amounted to approximately 60,000 cu. ft. of sawn boards per month. Although air drying is still the usual method used in seasoning sawn boards, kilns are also used and much of the material coming to the Union is artificially dried.

The common names given to the woods in the enumeration that follows are those most generally used, but each species may have a dozen or more names according to the province from which it derives. As an example:—

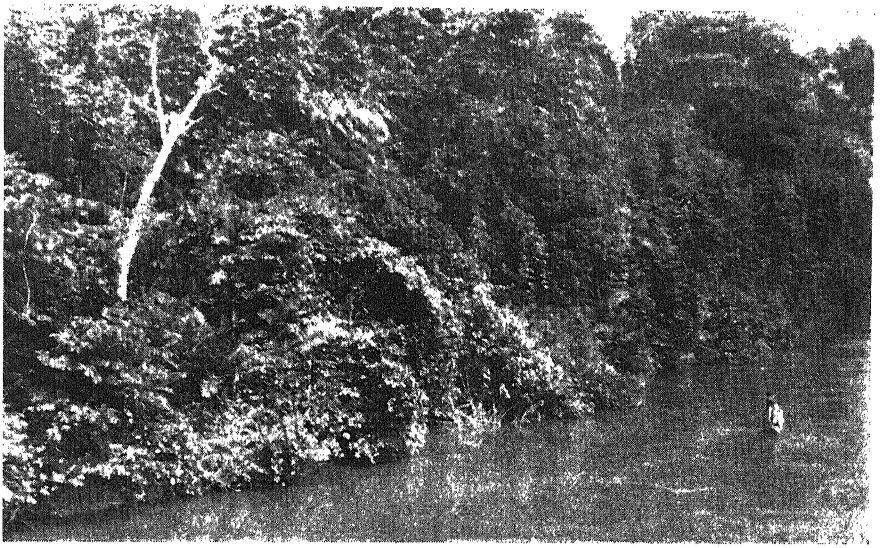
*1 *Chlorophora excelsa* known everywhere as Iroko, is also well known as Mvule, Kambala, Odum, Lusanga, Moreira and a host of other common and native names. To avoid confusion, the Timber Controller has recently drawn up a list of standard or trade names by which the timbers are to be imported into the Union and has prohibited the use in the Union of all other names for the species mentioned.

Many of the timbers mentioned are available also from the East Coast of Africa though it is mainly with the West Coast timbers that it is proposed to deal. The Belgian Congo, Gaboon, French Middle Congo, the Cameroons, and Nigeria are the more important territories from which sawn tmber and round logs can be obtained. From the small Portuguese colony of Cabinda logs only are available. Many of the species are common to all the territories
2 but there are a few, for example Okoume, which grow only in the
3 Gaboon. This species and to a lesser degree Limba, are the only species found in comparatively pure forests.

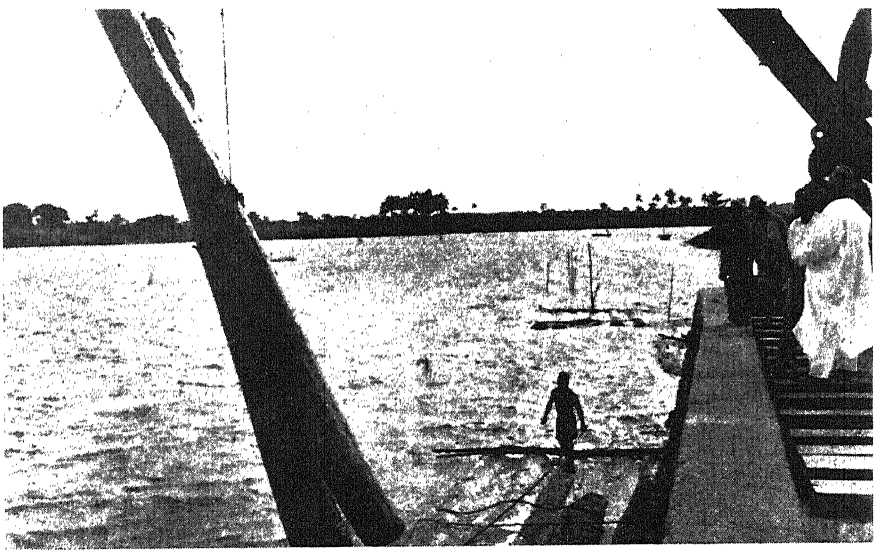
The other species are found scattered or in small groups.

Weights

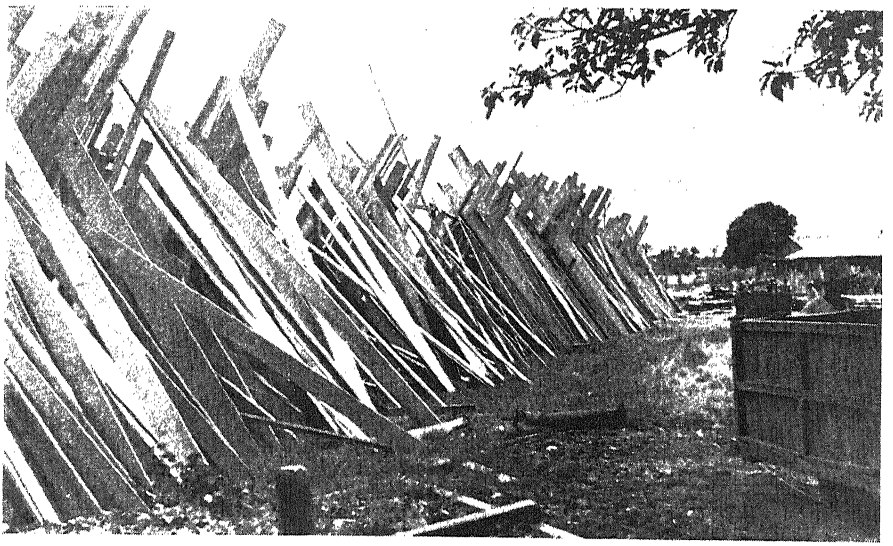
The weights given in the list of species which concludes this paper and in the description of the timbers which follows are all averages for air dry material (10 per cent. moisture content). A wide range of about 5 lbs. on either side of the average figure is not unusual in most species. The weights were determined from specimens collected at the Forest Products Institute and in nearly all cases have been found to check closely with what data was available from local reports from the various territories.



Dense forest growth near Port Francqui on the upper reaches of the Kasai River, one of the main tributaries of the Congo. Note the ubiquitous native canoe.



Breaking up the last portions of a timber raft on arrival at a Nigerian Government sawmill. The logs being hoisted out of the water are Nigerian mahogany.



Obeche boards racked for sun-drying to prevent pinhead borer attack before being stacked in the normal way to dry out further.



Logs of Limba, Ntola and Iroko assembled for shipment on the beach at Landana, Portuguese West Africa. Logs are pulled through the surf and loaded over the sides of steamers anchored in the bay.

Description of Species

Possibly the best known and certainly one of the most valuable
4 timbers from the West African territories is Iroko (*Chlorophora excelsa*). This wood is an excellent substitute for Burmah teak (*Tectona grandis*), and is second to none among hardwoods for general purposes. It is very durable, of medium weight (40 lb.) and its yellowish colour when freshly sawn, darkens to a pleasant brown or dark brown on exposure. It has a somewhat coarse texture and occasionally an interlocked grain, making it more difficult to finish than teak. Certain types contain silica which is very hard on knives. It is particularly suitable for furniture and good quality fittings, for panelling and general construction, including flooring and decking. Although an excellent wood also for outdoor use it is really too valuable to be used as sleepers. The sawdust has been known to affect sensitive skins but this is a most unusual occurrence.

A very large proportion of the furniture timbers imported before the war consisted of oak which varied in quality from the light easily worked Japanese oak to the heavier and stronger American
5 species. In colour and general appearance Limba (*Terminalia superba*) bears a resemblance to oak but lacks its figure. It is also somewhat lighter, weighing only 35 lb. It is straight in grain and rather coarse in texture and works easily under all tools. As the sapwood is wide precautions should be taken to guard against attack by borers as described in the following section. It may be used with advantage for the cheaper classes of furniture. It is also being used for airscrews and as a substitute for soft woods in mouldings and joinery, and for a host of general purposes too numerous to mention. Round logs have been used for plywood.

In exploiting these trees a proportion of them is found to have a dark central portion. This is not a true heartwood and would appear to be due to the uneven spreading of a discolouration which commences at the base of the tree and arises from incipient decay. The dark coloured wood which seldom occupies a very large proportion of the stem may be cut out and sold separately at a slightly higher rate. Boards so obtained are not as a rule large. Furniture made from them has been sold as African Walnut and by other names given it locally, and is not unattractive.

6 Idigbo (*Terminalia ivorensis*) is a wood very similar to Limba but slightly superior in quality, having a finer grain and being resistant to beetle attack. Its weight is 36 lb. It can be used for the same purposes. It was not met with in the Belgian Congo. In passing it may be of interest to note that barrel staves for wine casks, usually made from highly selected quartered oak, were being made in the
7 Cameroons for export to France from Mangrove (*Rhizophora racemosa*) an exceptionally dense dark red wood.

Numerous woods from West Coast territories can satisfactorily replace the various better grades of Philippine Mahogany. They
8 vary from the comparatively well-known Sapele (*Entandrophragma cylindricum*), an attractive reddish brown wood weighing 42 lb.
9 per cu. ft. to the lifht, softer species Gedu nohor (*E. macrophyllum*) of about 34 lb. These woods are not yet clearly separated botanically
10 and are often sold under the collective names of Lifaki or

Acajou which may include yet other species. All are suitable for furniture veneer and joinery.

The African mahoganies, the *Khaya* species, *Khaya anthotheca*, *K. grandifoliola* and *K. ivorensis*, are very similar to the above but usually of a darker brown and are more easily handled. They bear a very close relationship to the true mahogany (*Swietenia* sp.) and are generally preferred to the *Entandrophragma's* for furniture and cabinet making. The range in weight is much the same, from 32 to 45 lb. Another very closely related species is Scented guarea (*Guarea cedrata*). This wood has properties almost identical to Sapele but is of a lighter colour and usually finer texture and is used for the same purposes. It is scented when freshly sawn. Its weight is 38 lb.

A rather peculiar type of defect met with in perhaps one to two per cent. of the larger trees of *Entandrophragma* and other mahogany types of timber more particularly in the lighter woods, is the cross break, commonly called thunder crack. This resembles a compression failure and is definitely a weak area in the wood. Cases have been seen where planks sawn from such stems have broken across the grain at the slightest pressure leaving a very brash fracture.

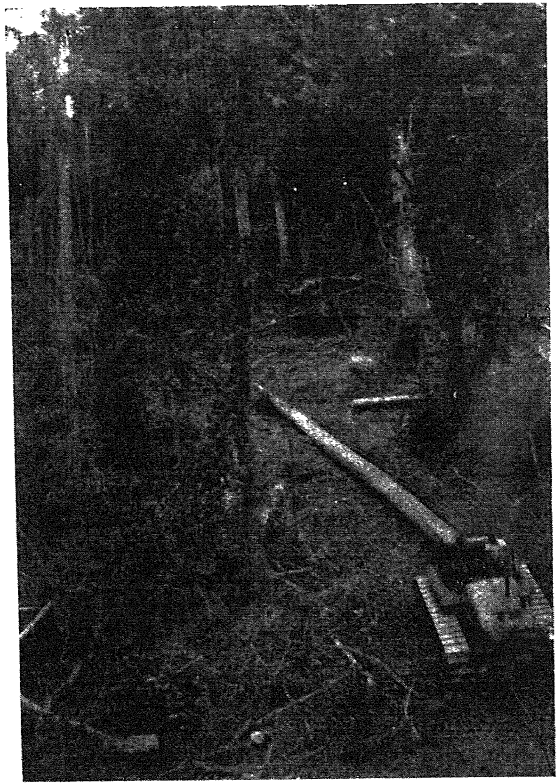
The lighter coloured Philippine mahoganies were to some extent replacing softwoods for certain purposes and the African equivalent for these might be found in such woods as Agba or Ntola (*Gossweilerodendron balsamiferum*), Avodire (*Turraeanthus vignei*) and Olon (*Fagara macrophyllum*). Agba is a light. greyish-brown even-textured wood very easily worked, weighing 30 lb. The sapwood which is rather resinous is usually removed in converting the logs into boards as it may be attacked by borers. This wood should make a good pattern makers' wood. Avodire is similar but whiter and could be used for the same purposes. Its weight is 31 lb. Olon is somewhat heavier and harder than the other two, and is slightly stronger and better figured. It has the typical mahogany stripe but has a yellowish colour. It weighs 35 lb.

Okoume (*Aucoumea klaineana*) was imported in round logs for some time before the war especially for plywood manufacture, for which it is excellently suited. It has also been used for general furniture manufacture and for many other purposes where a light soft wood of even texture is required. It is of a uniform pinkish colour, is easily worked and weighs 29 lb. It is not recommended as a general softwood substitute for building purposes, as it is inclined to be cross grained and hence weak in long lengths of small section.

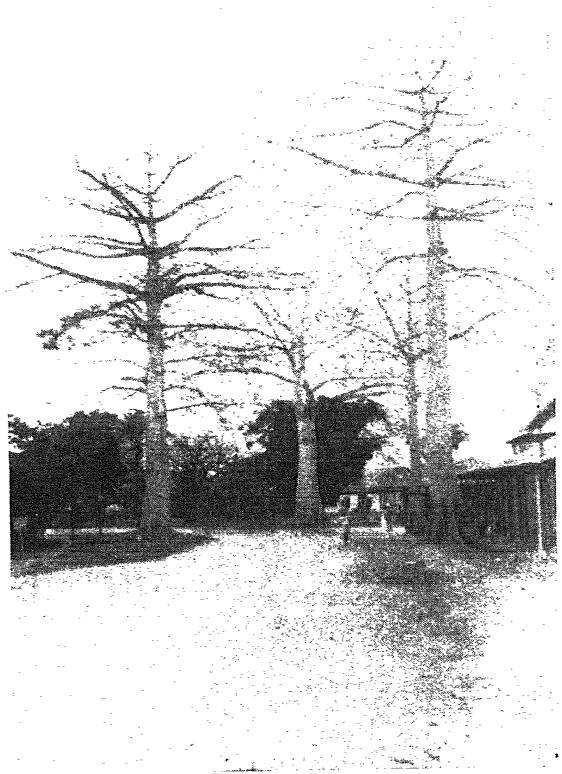
Mansonia (*Mansonia altissima*) might well replace walnut. This is an attractive brown wood weighing 37 lb. which is easily worked and finishes well. The grain is usually fairly straight and the texture fine and even.

A wood somewhat similar to the lighter types of birch though lacking the characteristic ray is Abura (*Mitragyna macrophylla*), commonly known as Bahia in French Territory. It is straight in grain, of even texture, and light brown in colour. It weighs 35 lb., works without difficulty and could be used for furniture, flooring, brush backs and numerous other purposes.

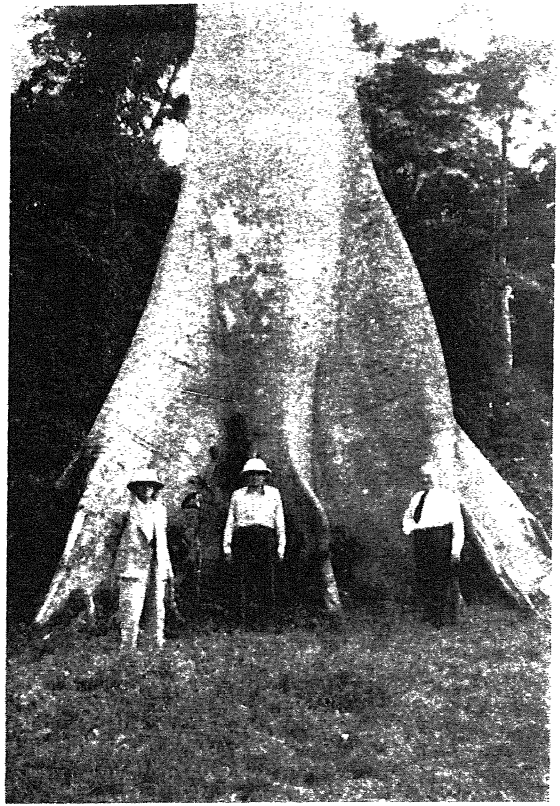
Among the furniture woods of medium weight, should be mentioned Lovoa wood (*Lovoa klaineana*), 35 lb., well known in



Extracting Limba logs from the Mayumbe forests, Belgian Congo. The log shown had a clean bole of sixty feet and diameter of 3′ 3″ above the butress. There is very little taper.



A group of Fuma (*Ceiba pentandra*) trees at Boma, near the mouth of the Congo River, Belgian Congo.





A forest giant, showing the spreading butresses typical of Limba, Obeche and Fuma, a group of which is shewn on the right.

Europe as African walnut and Dibetou. This is a particularly attractive brown wood with black and gold markings. It ought to to be used to a greater extent in the Union. Its grain is more like mahogany but the colouring is walnut. It is undoubtedly one of the premier furniture woods.

Very attractive though heavier woods for furniture are Wenge (*Milletia laurentii*) an almost black, highly figured wood (most suitable for flooring blocks). Padouck (*Pterocarpus soyauxii*) a similar wood to our local kiaat but darker in colour. Kevasingo (*Copaifera sp. arnoldiana?*) an attractively grained reddish or purplish brown wood. Opepe (*Sarcocephalus diderrichii*) a strikingly yellow, dense, coarse textured wood. Makore (*Mimusops heckelii*) a pleasant pinkish brown, fine textured wood of exceptional durability, and many others.

these are all durable woods weighing about from 47 to 50 lb. and are not likely to be imported for furniture on any scale on acount of their weight, and being more difficult to work than lighter though possibly less attractive woods. They deserve mention, however, as being suitable substitutes for the heavier hardwoods previously obtained from the Dutch East Indies for flooring blocks, heavy construction work and sleepers, such as Lagan, Balau and Marbou.

To the list of woods for sleepers and heavy construction work must be added Muave (*Erythrophleum guineense*) an attractively coarse grained brown wood which seasons exceptionally well in heavy sizes, although its weight is 62 lb. Agboin (or Dahoma) (*Piptadenia africana*) a coarse textured durable brown wood of 48 lb. per cu. ft., somewhat similar to Iroko in appearance. Sometimes used for furniture, but rather heavy. Limbalu (*Macrolobium dewevrei*) a brown wood weighing about 56 lb. per cu. ft. which is inclined to be cross-grained but is reported as being used extensively in the Belgian Congo for railway sleepers as it is available in good quantities. Kabulungu (*Autranella congolensis*), a heavy, hard, reddish brown, durable timber of 53 lb. It has a fine texture and turns well. Sawdust from the wood is said to cause sneezing. Lukulungu (*Irvingia gabonensis*), a very hard, heavy, durable wood of greenish brown colour and a weight of 63 lb. Eveuss (*Klainedoxa latifolia*) has practically the same properties as Lukulungu and is also similar in appearance but slightly darker in colour. Ekki (*Lophira procera*), a very heavy, exceptionally hard timber with coarse texture and purplish brown colour. Weight 65 lb. It is exceptionally durable and resists teredo attack. It has a wide sapwood which should be treated if a maximum life is desired. It is of interest to note that the fall offs and small sized material left over after sawing out the heavy dimensions from this wood, are squared and bored and exported for vine trellises as a substitute for Jarrah and other durable woods. Douissie (*Afzelia africana*), although not so well known as some of the above, deserves mention on account of its special characteristics. It resembles Iroko in so far as it is of a rather coarse appearance and brownish colour and is stated to be very durable. It is heavier, 47 lb., and turns a rather redder colour after exposure but can be used for the same purposes, more particularly for joinery and construction work.

Finally, there is a class of very soft, light woods weighing less
43 than 28 lb. The best known of these is Obeche (*Triplochiton scleroxylon*), a particularly suitable substitute for Clear Pine previously imported from America for pattern making. It is a clean, even-grained, very easily worked wood which seasons exceptionally well.
44 45 It weighs 24 lb. Ilombo (*Pycanthus kombo*) and Sindru (*Alstonia congensis*) are two other easily worked woods suitable for shelving, light carpentry, toy making and boxes. Both weigh 26 lb.
46 Very common trees on the West Coast are Ceiba (*Ceiba pen-*
47 *tandra*), 22 lb. and Sanga (*Musanga smithii*), the lightest of all, weighing only 14 lb., which is suitable for special purposes such as veneer cores, floats, certain types of corks and mounting boards. In fact it is a good substitute for Balsa wood.

All these light soft timbers need rapid seasoning and careful handling to avoid discolouration and an inexpensive preservative treatment would ensure immunity against wood borers.

Beetle Attack

The *lyctus* beetle which is the cause of so much damage to the sapwood of hardwood timbers in the Union was not noticed in timber stacks in West Africa to the extent expected. This was no doubt due partly to much of the timber being shipped before the beetle had time to do much damage and partly to the wood being wetter than the *lyctus* likes. There are, however, many wood borers, one of the most active being *Platypus dispar*, a pin-hole borer which bores into logs and stacks of green timbers as soon as the trees are felled or the logs sawn. Long continuous masses of frass which are pushed out of the boring are characteristic of this beetle which attacks both sap and heartwood and leaves the wood as soon as it dries out. When dry, the wood is an unsuitable medium to support the fungus growth on which the beetle lives, the spores of which are introduced by the beetle.

The best preservative measures against pin-hole and similar types of borer attacking green timber are rapid conversion and drying of stock. If logs cannot be sawn immediately, they may be stored in dams or canals which, apart from preventing attack, is an excellent method of storage.

Beetles invariably attack the under or cooler side of logs in preference to the more exposed portions and another method that is useful in minimising damage by these pests is to arrange the log deck on a slight slope so as to facilitate a daily half turn of each log in order to expose all surfaces to the sun.

Preservative treatment of logs is not as a rule practicable. As soon as logs have been sawn the green boards should either be dried in a kiln or, if of a species like Obeche which will stand such treatment, racked for rapid sun drying as indicated in the accompanying illustration, for a week or so depending on the weather. After this they may usually be stacked in the normal way for further seasoning without danger of attack. Another method is to spray the boards before stacking for drying with chemicals such as benzol, 75 per cent.; orthonitrodiphenyl, 25 per cent. Once the moisture content falls somewhere below 40 per cent. the boards are in any case safe from attack by pin-hole or ambrosia beetles.

The prevention of damage by *lyctus* and other beetles attacking the sapwood of dry or almost dry timber is not so simple. In this case the beetle actually lives on the wood and unlike the pin-hole borer is not

dependant on sufficient moisture to cultivate a fungous diet in its burrows. The first signs even of a fairly severe attack are not apparent on the outside of the boards for some time, and the flight holes of the adult beetle are usually only seen from seven to twelve months after the eggs have been laid in the pores of the wood. The removal of all sapwood is sometimes practised with species such as Ntola in which it is in any case of a very gummy nature. This is, however, a wasteful method with most species. Kiln drying at sufficient temperature, sterilises wood but it does not prevent future attack. Sterilised wood manufactured and finished off with paint, varnish and other preparations which completely close up the pores on all surfaces is however very unlikely to be attacked.

Preservative treatment in the form of a dip is not effective after the surface is planed or the board sawn in the process of manufacture. A further dip in some such preservative as borax or pentachlorophenol in fuel oil solution, after manufacture then becomes necessary.

An alternative way to protect all sapwood whether it be planed or resawn thereafter is to give a full preservative treatment in a 5 per cent. solution of zinc chloride or zinc sulphate after air seasoning, and to rapidly dry off the excess moisture in a day or two's kiln drying. This method is routine practice at the Forest Products Institute with such woods as Kiaat which contains a high percentage of sapwood. Costs are recovered many times over by the additional utilisable wood obtained.

The destruction by burning of all badly attacked timber and slash in the vicinity of sawmills is of assistance in keeping down *lyctus* and other pests generally. Young, fast growing trees with a high percentage of sapwood and high starch content are the most likely to be attacked.

Future Trade Prospects

Although only some of the timbers exploited from the West African territories have been mentioned, enough has been said to show that woods for any purpose are available. At present the main supply problem is of course shipping. Other problems are lack of suitable machinery and spare parts. Some of the mills in French territory are only working at half capacity for these reasons.

In regard to their future on the South African market it can be said at once that, although many of them can and are being used to advantage to replace coniferous softwoods normally imported from Europe or America, there are no coniferous timbers amongst them. Owing to difficulty of extraction and comparatively costly conversion and transport, the soft tropical timbers cannot ever seriously compete in the post-war open market with low-priced coniferous building timbers produced locally or imported from well-established sources overseas. In West Africa itself coniferous timber is on occasions imported from North America. Many of them, moreover, are liable to borer attack unless properly treated, a risk seldom met with in coniferous timbers.

Except for special purposes including possibly pattern-making, cores, or mounting boards, none of the tropical softwood timbers is likely to become established on the South African market after the war, least of all as substitutes for general building timber.

With regard to furniture timbers and other hardwood uses the position is rather different. To begin with, tropical hardwoods and semi-hardwoods are competing on a much more favourable basis. In normal times the value of hardwoods is generally at the very least double that of softwoods while in many cases it may be three or four times. Furniture timbers are

selected for their appearance and ease in working and the qualities of timbers such as Iroko, Lovoa, the mahoganies and others which have been mentioned fulfil these requirements entirely. Furthermore, the use of many of them has more or less been forced on the market and many of their good qualities are becoming comparatively well-known and in this way a further demand for them is being created.

Government Departments, including such large users of timber as the Railways, Public Works, and Defence are becoming interested in the properties of woods not before used to any extent in the Union and practical tests on a number of comparatively unknown timbers are being made by some of the Departments concerned. Especially is this the case at the Forest Products Institute where the weights, strength, seasoning and many other physical properties of some score of West African timbers are being systematically investigated. It is always difficult to introduce new woods, but a wood, the properties of which are known, has a great advantage.

For several years after the war reconstruction in Europe will demand very large volumes of timber and prices generally are likely to remain considerably above pre-war level.

It has been mentioned that on the whole conversion and seasoning methods are good and strict control of timber exports is exercised by more than one of the West African Governments ensuring that only good quality material is shipped. For the reasons given above it is not unreasonable to conclude that many of the contacts made now will be further developed after the war and an important if perhaps not very large trade will persist especially with the territories most conveniently situated.

The fact must not be lost sight of that the mother countries were the main purchasers of the colonial woods before the war and this state of affairs is likely to return, but at the same time it is difficult to imagine that the trade connections so laboriously built up with this country are likely to be easily severed.

TIMBERS MENTIONED IN THE TEXT

A number of the names included in these lists, although not mentioned in the text, are given so as to ensure as wide a basis as possible for determination of botanical identity. The territories in which the common names, so far as is known to the writer, are current, and in which the respective timbers are prevalent, are indicated in the first list by the letters in brackets following each. They are as follows:

B ..... Belgian Congo.
C ..... French Cameroons.
F ..... Gaboon and Middle Congo.
G ..... Gold Coast.
N ..... Nigeria.
P ..... Portuguese West Africa and Cabinda.

In the first of the two lists the text reference to each species follows the botanical name. In the second, it follows the common name. In the second, the average weight in pounds per cubic foot of each timber is indicated by the figure following the botanic name. Those common names in the first list that are prefixed by an asterisk conform to the British Standards Institution's Specification No. 881 of 1939 "Nomenclature of Hardwoods."

Arranged by Common Names

*Abura (GN): *Mitragyna macrophylla* 25.
Acajou (F): *Entandrophragma* spp., *Khaya* spp. 11.
Acajou blanc (F): *Khaya anthotheca* 12.
*Afara (GN): *Terminalia superba* 3.
*African mahogany (GN): *Khaya ivorensis* 14.
African nutmeg (N): *Pycnanthus kombo* 45.
*African walnut (GN): *Lovoa klaineana* 27.
African whitewood (G): *Triplochiton scleroxylon* 43.
*Agba (N): *Gossweilerodendron balsamiferum* 16.20.
Agboin (NG): *Piptadenia africana* 35.
Apopo (N): *Lovoa klaineana* 26.
Aprono (NG): *Mansonia altissima* 24.
Arere (F): *Triplochiton scleroxylon* 43.
*Avodire (GN): *Turreanthus vignei* 18.21.
Ayouss (F): *Triplochiton scleroxylon* 43.
Azobe (F): *Lophira procera* 41.

Badi balinga (F): *Sarcocephalus diderrichii* 32.
Bahia (CF): *Mitragyna macrophylla* 25.
Baku (G): *Mimusops heckelii* 33.
Bediwunua (G): *Canarium schweinfurthii*.
Bibolo (C): *Lovoa klaineana* 26.
Bilinga (CF): *Sarcocephalus diderrichii* 32.
Bokumbu (B): *Erythrophleum guineense* 34.
Bokungu (B): *Piptadenia africana* 35.36.
Bongassie (F): *Lophira procera* 41.
Bonkole: *Lophira procera* 41.
Bosse (CF): *Guarea cedrata* 15.
Bubinga (F): *Copaifera* sp. cf. *arnoldiana* 31.
Buhulu (F): *Copaifera sp. cf. arnoldiana* 31.
Buhulu (B): *Khaya* spp., *Entandrophragma* spp.

Cedar (G): *Entandrophragma macrophyllum* 9.
Entandrophragma utile.
*Ceiba (G): *Ceiba pendtandra* 46.
Cottonwood (N): *Ceiba pentandra* 46.

Dabema (C): *Piptadenia africana* 35.36.
Dahoma (G): *Piptadenia africana* 36.
Dibetou (F): *Lovoa klaineana* 28.
Ditshipi (B): *Macrolobium dewevrei* 37.
Douisse (F): *Afzelia africana* 42.
Douka (F): *Mimusops heckelii* 33.
Dubini (G): *Khaya ivorensis* 14.
Dubini-biri (G): *Lovoa klaineana* 26.

Edinam (G): *Entandrophragma macrophyllum* 9.
Egba (N): *Rhizophora racemosa* 7.
*Ekki (GN): *Lophira procera* 41.
Emeri (G): *Terminalia ivorensis* 6.
Emien (F): *Alstonia congensis* 45.
Erun (N): *Erythrophleum guineense* 34.
Eveuss (F): *Klainedoxa latifolia* 40.

Frake (C): *Terminalia superba* 3.5.
Framire (C): *Terminalia ivorensis* 6.
Fuma (B): *Ceiba pentandra* 46.
Fuma du Mayumbe (F): *Ceiba pentandra* 46.

*Gedu nohor (GF): *Entandrophragma macrophyllum* 9.
Gedu nohor (F): *Entandrophragma utile*.
Guarea (GN): *Guarea cedrata*.
Gulumanzi (B): *Sarcocephalus diderrichii* 32.

*Idigbo (GN): *Terminalia ivorensis* 6.
Ilombo (F): *Pycnanthus kombo* 44.
*Iroko (GFC): *Chlorophora excelsa* 1.4.

Kabulungu (B): *Autranella congolensis* 38.
Kaku (G): *Lophira procera* 41.
Kalungi (B): *Entandrophragma macrophyllum* 9.
Kambala (BFC): *Chlorophora excelsa* 1.
Kassa-kassa (B): *Erythrophleum guineense* 34.
Kevasingo (F): *Copaifera* sp. cf. *arnoldiana* 31.
Kibaba (P): *Khaya antholheca* 12.
Kitwa (P): *Entandrophragma macrophyllum* 9.
Kusia (G): *Sarcocephalus diderrichii* 32.
Kwabohoro (G): *Guarea cedrata* 15.

Libuyu (B): *Khaya* spp., *Entandrophragma* spp.
Lifaki (B): *Entandrophragma congoense, Entandrophragma cylindricum* 8.
Limba (B): *Terminalia superba* 3.5.
Limbalu (B): *Macrolobium dewevrei* 37.
Limbo (FC): *Terminalia superba* 3.5.
Lovoa (GN): *Lovoa klaineana* 26.
Lukulungu (B): *Irvingia gabonensis* 39.
Lusanga (B): *Chlorophora excelsa* 1.

Mahogany (N): *Khaya grandifoliola* 13.
*Makore (GN): *Mimusops heckelii* 33.
Mangrove (C): *Rhizophora racemosa* 7.
*Mansonia (GN): *Mansonia altissima* 24.
Moabi (F): *Mimusops heckelii* 33.
Moreira (P): *Chlorophora excelsa* 1.
Muave (P): *Erythrophleum guineense* 34.
Mufuma (P): *Ceiba pentandra* 46.
Mukulungu (B): *Autranella congolensis* 38.
Mulimba (P): *Terminalia superba* 3.5.
Mulombo (P): *Pycnanthus kombo* 44.
Mupatu (B): *Canarium schweinfurthii.*
Mutzekambole (B): *Gossweilerodendron balsamiferum* 16.17.20.
Mvule: *Chlorophora excelsa* 1.

Nigerian golden walnut (N): *Lovoa klaineana* 26.
Nigerian mahogany (N): *Khaya grandifoliola* 13.
Noyer du Gabon (F): *Lovoa klaineana* 26.
Ntola (BP): *Gossweilerodendron balsamiferum* 17.

*Obeche (GN): *Triplochiton scleroxylon* 43.
Odum (G): *Chlorophora excelsa* 1.
Ofram (G): *Terminalia superba* 3.5.
Ofun (N): *Mansonia altissima* 24.
Okoume (CF): *Aucoumea klaineana* 2.23.
Olon (CF): *Fagara macrophyllum* 19.22.
*Opepe (NG): *Sarcocephalus diderrichii* 32.
Ossimiale (F): *Piptadenia africana* 35.36.
Osun (N): *Pterocarpus soyauxii* 30.
Otie (G): *Pycnanthus kombo.*
Ozigo (F): *Pachylobus pubescens.*

Padouck (F): *Pterocarpus soyauxii* 30.
Potrodom (G): *Erythrophleum ivorensis.*

*Sapele (G): *Entandrophragma cylindricum* 8.
Sapilli (F): *Entandrophragma cylindricum* 8.
*Scented guarea (GN): *Guarea cedrata* 15.
Sida (N): *Lovoa klaineana* 26.
Sindru (G): *Alstonia congensis* 45.
Subaha (G): *Mitragyna macrophylla* 25.
Sanga (B): *Musanga smithii* 47.

Tali (F): *Erythrophleum guineense* 34.

Umbrella tree (N): *Musanga smithii* 47.

Wamba (B): *Macrolobium* spp.
Wawa (G): *Triplochiton scleroxylon.*
Wenge (B): *Millettia laurentii* 29.
Wild mango (N): *Irvingia gabonensis* 39.

Botanically Arranged

Afzelia africana (47): Douissie 42.
Alstonia congensis (26): Sindru; Emien 45.
Aucoumea klaineana (29): Okoume 2.23.
Autranella congolensis (53): Kabulungu; Mukulungu 38.
Bombax pentandrum: see *Ceiba pentandra.*
Canarium schweinfurthii (29): Bediwunua; Mupatu.
Ceiba pentandra (22): Ceiba; Cottonwood; Fuma; Fuma du Mayumbe; Mufuma 46.
Chlorophora excelsa (40): Moreira; Iroko; Kambala; Lusanga; Mvule; Odum 1.4.
Copaifera sp. cf. *arnoldiana* (53): Bubinga; Kevasingo 31.
Dumoria heckelii: see *Mimusops heckelii.*
Entandrophragma angolense: see *E. macrophyllum.*
,, *congoense*: Lifaki.
,, *cylindricum* (42): Sapele; Sapilli; Lifaki 8.
,, *macrophyllum* (34): Cedar; Edinam; Gedu nohor; Kalungi; Kitwa 9.
,, *utile*: Gedu nohor; Cedar.
Eriodendron anfructuosum: see *Ceiba pentandra.*
Erythrophleum guineense (62): Bokumbu; Erun; Muave; Tali; Kassa-kassa 34.
,, *ivorensis* (55): Potrodom.
Fagara macrophyllum (35): Olon 19.22.
Gossweilerodendron balsamifera (30): Agba; Mutzekambole; Ntola 16.20.
Guarea cedrata (38): Bosse; Guarea; Kwabohoro; Scented guarea 15.
Irvingia bateri: see *Irvingia gabonensis.*
Irvingia gabonensis (63): Lukulungu; Wild mango 39.
Khaya anthotheca (35): Acajou blanc; Kibaba 12.
,, *grandifoliola* (40): Mahogany; Nigerian mahogany 13.
,, *grandis*: see *K. grandifoliola.*
,, *ivorensis* (35): African mahogany; Dubini 14.
Klainedoxa latifolia (60): Eveuss 40.
Lophira alata var. *procera*: see *L. procera.*
,, *procera* (65): Azobe; Bongassie; Bonkole; Ekki; Kaku 41.
Lovoa klaineana (35): African walnut; Bibolo; Dibetou; Noyer du Gabon; Dubini-biri; Lovoa ; Apopo; Nigerian golden walnut; Sida 26.
Macrolobium dewevrei (56): Ditshipi; Limbalu 37.
,, sp: Wamba.
Mansonia altissima (37): Aprono; Mansonia; Ofun 24.
Millettia laurentii (50): Wenge 29.
Mimusops heckelii (47): Baku; Makore; Moabi; Douka 33.
Mitragyna macrophylla (35): Abura; Bahia; Subaha 25.
,, *stipulosa*: see *M. macrophylla.*
Musanga smithii (14): Umbrella tree; Sanga 47.
Pachylobus pubescens (38): Ozigo.
Piptadenia africana (48): Agboin; Bokungu; Dabema; Dahoma; Ossimiale 35.36.
Pseudocedrela cylindricum: see *Entandrophragma cylindricum.*
Pterocarpus soyauxii (50): Osum; Padouck 30.
Pycnanthus kombo (26): Ilombo; Mulombo; Otie; African nutmeg 44.
Rhizophora racemosa (61): Egba; Mangrove 7.
Sarcocephalus diderrichii (47): Badi balinga; Bilinga; Gulumanzi; Kusia; Opepe 32.
,, *trilesii*: see *S. diderrichii.*
Terminalia ivorensis (36): Emeri; Framire; Idigbo 6.
,, *superba* (35): Afara; Frake; Limba; Limbo; Mulimba; Ofram 3.5.
Triplochiton johnsonii: see *T. scleroxylon.*
,, *scleroxylon* (24): African whitewood; Arere; Ayouss; Wawa; Obeche 43.
Turreanthus vignei (31): Avodire 18.21.
Trichilia cedrata: see *Guarea cedrata.*

HISTOLOGICAL DISTRIBUTION OF WATTLE BARK TANNIN

By H. A. LUCKHOFF

(Research Officer, Division of Forestry.)

THESE investigations were started with a view to establishing the extent to which the tannin content of wattle bark is correlated with microscopic structure and to ascertain whether its manner of distribution varies characteristically with different types of bark. The wattle bark industry has long realised that the tannin content of bark from different wattle-growing areas differs. For example, black wattle bark of a given thickness from the Eastern Transvaal shews a consistently higher tannin content than that from certain parts of the Natal Midlands. In the light of knowledge that has accumulated since the inception of Government wattle bark inspection, it is now possible to divide black wattle (*Acacia mollissima* Willd.) bark roughly into four regional classes which are described in detail in the section following the ensuing general description of bark anatomy and notes on the experimental methods used in the investigation.

Anatomy of Wattle Bark

The term "bark" as commonly used in the industry comprises all the tissues lying outside the cambium. Botanically, the term applies to the superficial corky layer only, but its wider application is so firmly entrenched that its use is adhered to throughout this paper in preference to the more correct "phloem" or "bast," elements of which preponderate in the tissue lying outside the cambium. A description of the successive layers composing it follows.

Epidermis.

The epidermis consists of a single peripheral layer of round or oval cells. They contain no chlorophyll, and the walls are cuticularised, particularly on the outer wall or cuticle. In young bark the epidermis forms a compact layer and in young branches many of the cells are elongated into hairs. The young epidermis is also provided with numerous stomata arranged in approximately longitudinal rows. As the bark ages the epidermis ruptures and becomes fragmentary until finally in old bark it completely disappears, and a layer of corky cells containing lenticels or "breathing pores" develops in its place.

Cork layer or phellem.

In older bark the epidermis has completely disappeared, its place being taken by a cork layer or phellem. These cork cells are elongated, have thick suberised walls and no living contents and are arranged in very regular rows. Immediately inside the cork is a meristematic layer, the phellogen or cork cambium. Towards the outside the phellogen produces new cork cells and on the inside the secondary cortex.

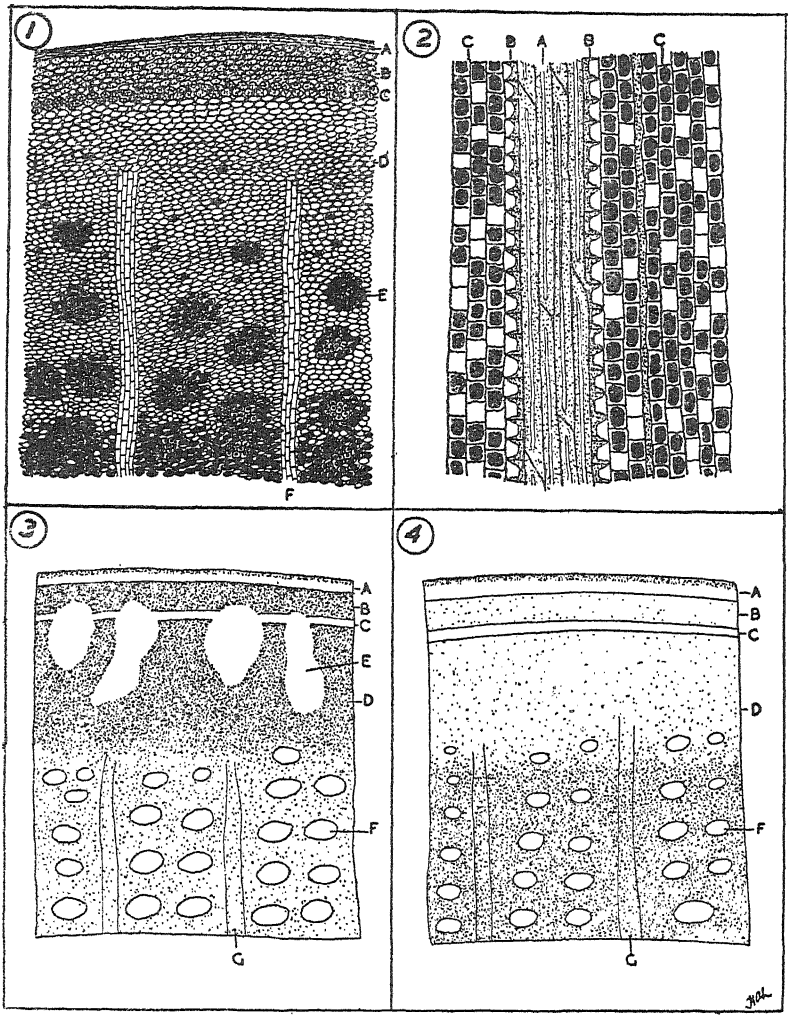


FIG. 1.—Section of silver wattle bark from Vryheid. (a) Cork layer. (b) Cortical parenchyma cells containing chlorophyll. (c) Pericycle. (d) Phloem parenchyma. (e) Fibre bundle surrounded by tannin containing cells. Black bodies represent tannin precipitate. Note sparse occurence of tannin cells. (f) Medullary ray.

FIG. 2.—Longitudinal section of portion of New Hanover bark. (a) Fibre bundle. (b) Sheath of collenchymatous cells with thickened inner walls. (c) Phloem parenchyma cells containing tannin precipitate.

FIG. 3.—Diagrammatic drawing of Piet Retief bark shewing concentration of tans in outer tissues and pockets of tannin-free cells. (a) Cork layer. (b) Cortex. (c) Pericycle. (d) Outer phloem parenchyma containing bulk of tannin cells. (e) Pocket of tannin-free cells. (f) Fibre bundle. (g) Medullary ray.

FIG. 4.—Diagrammatic drawing of Mid Illovo bark shewing concentration of tans in inner tissues and almost complete absence towards outside. (Terminology as in Fig. 3.)

Note.—In Figs. 3 and 4 tannin concentration indicated by stippling.

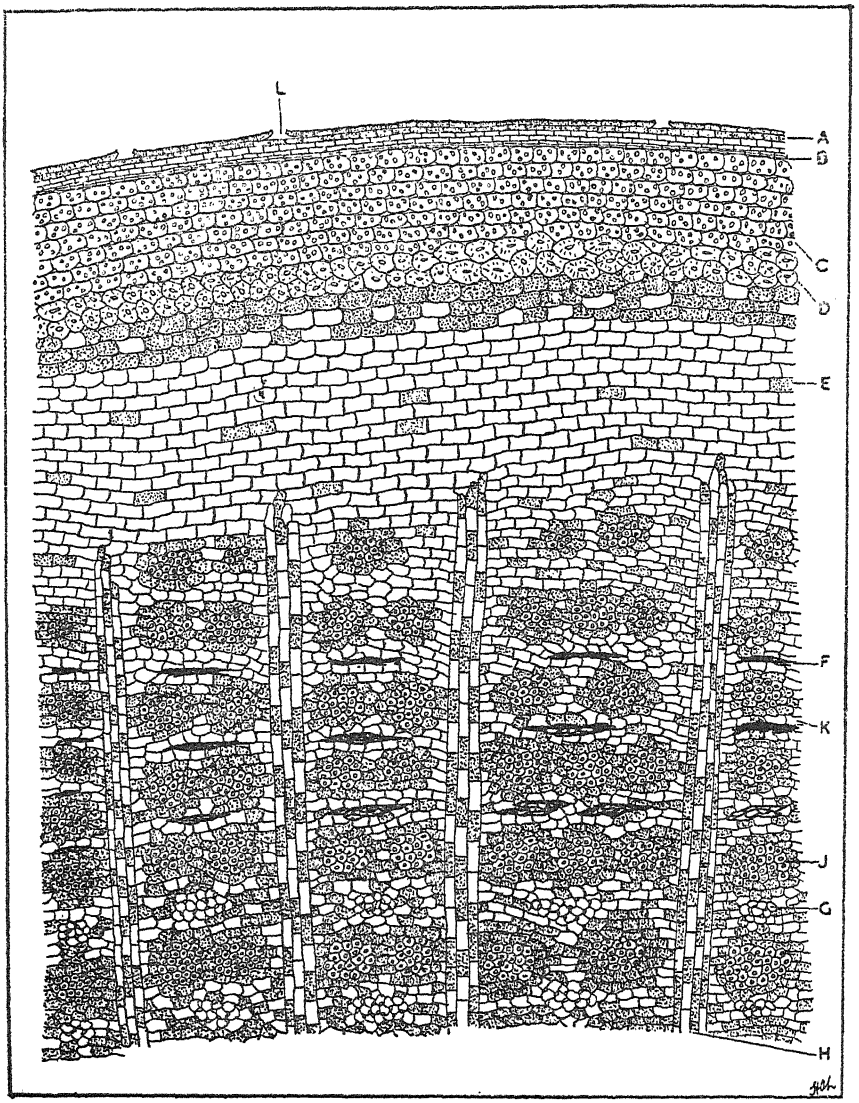


FIG. 5.—Section of black wattle bark from Natal Midlands. (Stippling in cells indicates tannin precipitate.) (a) Layer of cork cells. (b) Cork cambium. (c) Cortical parenchyma cells containing chlorophyll. (d) Pericycle. (e) Main phloem parenchyma tissue. (f) Strip of compressed, functionless sieve-tubes and companion cells. (g) Normal sieve-tubes and companion cells. (h) Medullary ray. (j) Bast fibre bundle. (k) Phloem parenchyma cells.

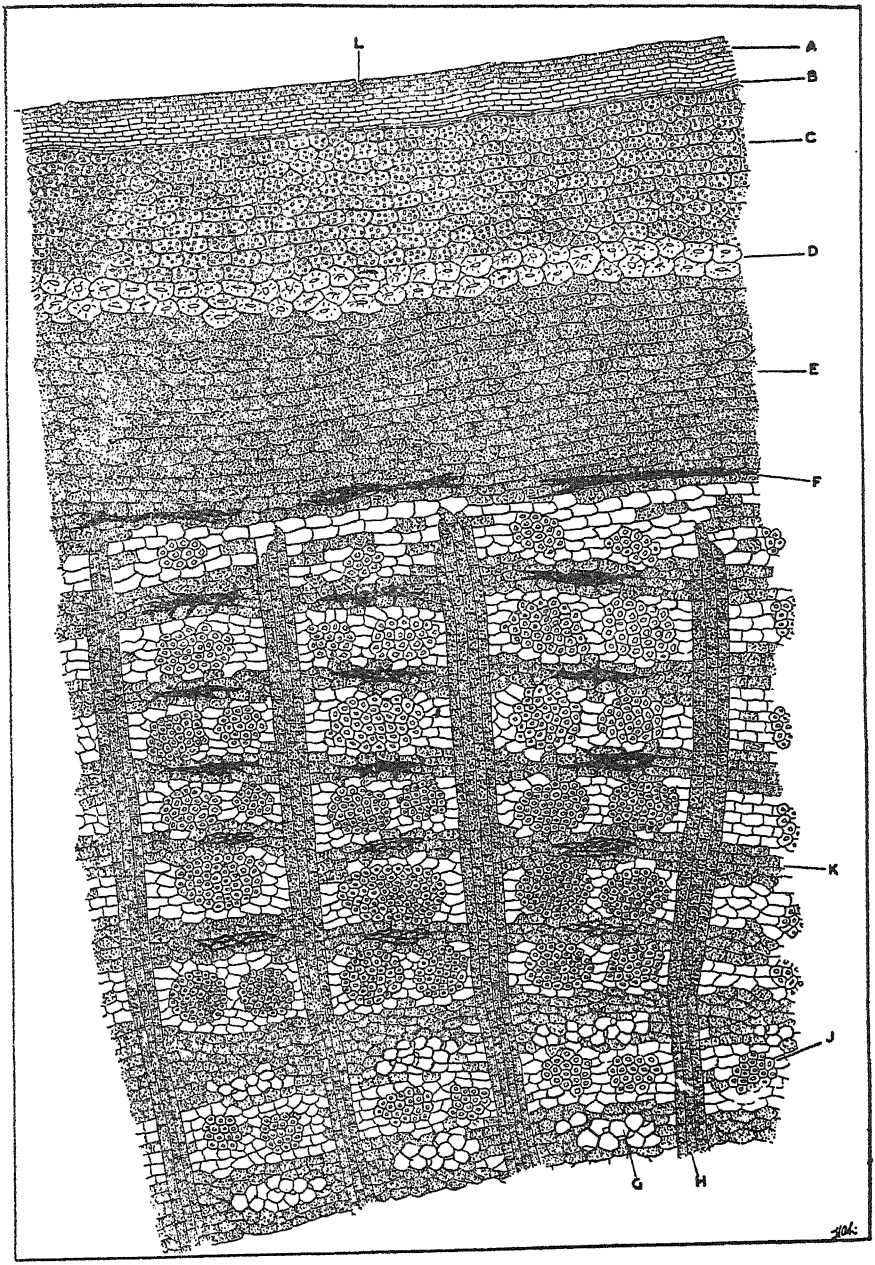


FIG. 6.—Eastern Transvaal bark. (Stippling in cells indicates tannin precipitate.) (a) Layer of cork cells. (b) Cork cambium. (c) Cortical parenchyma cells containing chlorophyll and tannin precipitate. (d) Pericycle. (e) Main phloem parenchyma tissue in which majority of tannin cells occur. Width drawn disproportionately. Should be wider than shewn. (f) Strip of compressed, functionless sieve-tubes and companion cells. (g) Normal sieve-tubes and companion cells. (h) Medullary ray. (j) Bast fibre bundle. (k) Phloem parenchyma cells. (l) Lenticel.

Secondary cortex.

The cells of the secondary cortex are fairly thick-walled, somewhat tangentially elongated, and rich in protoplasmic content. They contain chlorophyll. This layer is a number of cells thick.

Pericycle.

Separating the secondary cortex from the central cylinder of phloem is the pericycle which consists of a ring of two or three layers of prosenchymatous cells. The walls of these cells are lignified and much thickened, shewing distinct striations and pit canals. The lumena are necessarily small. With safranin the pericycle has bright staining properties and is very conspicuous.

Phloem.

The bast or phloem, the thickest portion of the bark, consists of all the tissues inside the pericycle. It comprises three distinct types of cells: sieve-tubes and companion cells, bast fibres and parenchyma. The sieve-tubes and companion cells are arranged in regular radial groups between the bast fibre bundles. Only in the young or secondary phloem (near the wood) do the sieve-tubes and companion cells function normally. Towards the periphery they become crushed by the surrounding cells and eventually nothing remains but dark irregular bands of crushed cells. These bands have deep staining properties and are generally extremely conspicuous. Bast fibres are very abundant in black wattle bark and are grouped in definite oval bundles which are arranged in regular concentric rings. Surrounding the fibre bundle there is a sheath of collenchyma cells with the inner corners thickened. The fibre bundles are largest and most numerous a short distance from the wood and generally become smaller and thin out towards the pericycle. The rest of the phloem tissue consists of thin-walled parenchyma cells. Immediately inside the pericycle this phloem parenchyma forms a continuous tissue, varying considerably in thickness, before it becomes interspersed wth the bast fibre bundles. Running radially through the phloem are the medullary rays which are composed of rectangular parenchyma cells, extremely regularly arranged, and generally 3-5 rows thick. The medullary rays seldom run right to the pericycle but peter out in the parenchyma, generally at about the end of the bast fibre zone.

Experimental Methods

Numerous sections of wattle bark, 10-25 microns in thickness, were cut by means of a sledge microtome, stained and examined under a microscope. In order to determine the best tannin indicator, reaction to iron salts, bichromate of potash, ammonium molybdate and acetate of copper was tested. Of these four reagents, the bichromate of potash was found to be quite suitable and also more convenient than the others, and was therefore used exclusively.

The staining of the sections demands care to ensure that no tannic acid leaches out of the cells during the process. In preserving the bark between the time of stripping and sectioning and also in the process of sectioning, water or any fluid that might leach out the tans could not be used. Two methods of staining were used.

Staining after sectioning.

In this case small blocks of bark after having been cut from the tree were immediately placed in a specimen tube containing a 50/50 mixture of 95% alcohol and glycerine. The same solution is also used in sectioning. The advantage of this method is that the bark can be left in the solution for long periods, and it is also softened and sectioning thus facilitated. Its drawbacks are that a certain amount of tannic acid is leached out by the solution. After sectioning the specimens were stained in a 2½% potassium bichromate solution for from 15 minutes to one hour.

Staining before sectioning.

In this case the bark blocks immediately after being removed from the tree were placed direct in the 2½% potassium bichromate solution. This method has the advantage that all the tans are immediately precipitated and there is no possibility of any leaching taking place. Its drawbacks are that the bark becomes hard and brittle and sections with difficulty. The outer layers of bark moreover often become so clogged with precipitate that the solution does not penetrate right to the interior. As a safeguard, therefore, sections immediately after being cut were always replaced in the solution for ten to fifteen minutes to ensure that all the tannin had been reacted upon. To prevent the drying out of the bark while in transit from the tree to the laboratory, where it was not possible to place it directly in potassium bichromate or glycerine-alcohol solutions, the blocks were coated with paraffin wax and placed in corked specimen tubes. Others were wrapped closely in tin foil or waterproof paper.

Sections of dry bark were also cut, the bark being soaked in potassium bichromate for several days before sectioning. Here again the bark was so hard and brittle that it was difficult to get a complete section.

Numerous sections were also cut for anatomical study and stained with Delafield's haematoxylon-safranin combination.

Distribution of Tannin in Wattle Bark

The tannin in wattle bark is always most abundant in the phloem parenchyma cells. In much of the bark of high tannin content every parenchyma cell is filled with a dark brown precipitate. The tannin is concentrated either in the outer parenchyma tissue immediately inside the pericycle or in the bast fibre region. Frequently the tannin cells in the fibre region form a regular rectangular pattern, the fibre bundles falling in the rectangles. Sometimes their distribution is quite irregular or they may be grouped round the fibre bundles forming distinct rings. The first two types of distribution generally occur in barks of high tannin content and the ringed type in barks of low content. In the sieve-tubes and companion cells tannin rarely occurs and in the pericycle never. In barks of high tannin content tannin is generally present in the chlorophyllous cells outside the pericycle but is usually very much less abundant than in the phloem parenchyma. In barks of low content tans are either absent from these chlorophyll cells or of irregular occurrence. The outer few rows of cork cells are always of a medium brown colour but whether this indicates the presence of tannin or results

directly from the staining is doubtful. Probably the latter. Even if it is tannin the amount contained by the cork cells is so minute that it can be disregarded. The inner layers are generally colourless.

Black Wattle Bark.

Black wattle bark will now be dealt with under the main regional classes.

(*a*) *South Eastern Transvaal (Piet Retief, Iswepe, etc.)*

This bark in comparison with that from the Midlands of Natal is generally characterised by its high tannin content and fibrous nature, as confirmed by microscopic examination. It varies slightly in external grain from coarse to very even. The fibre bundles are very numerous and concentrated and the tannin content very high, as evidenced by the presence of a deep brown precipitate in almost every parenchyma cell. Paulpietersburg also possibly falls into this class.

In the cortical assimilatory tissue and the phloem parenchyma, in which in prime bark the bulk of the tans are concentrated, every cell is generally filled with a deep brown precipitate. In the region of the bast fibre bundles the concentration of tans is markedly less. In the fibre bundles themselves precipitate never occurs and in their associated parenchyma cells only seldom. A fair proportion of the latter are quite colourless. In this area the tannin cells are as a rule not closely associated with the bundles but generally form a rectangular pattern with the bundles lying in the rectangles. All ray cells are generally filled with a tannin precipitate.

Frequently irregular pockets of completely tannin-free cells appear in the cortical and outer phloem parenchyma. These probably result from injury received by the bark or possibly from physiological disturbance. In bark affected with gummosis, tannin gradually disappears, the impoverishment being transmitted to unaffected areas from the region of gumming. Whether examined bark containing these pockets had suffered from gummosis could not be ascertained although it appears quite probable. They were most frequent in bark from the South Eastern Transvaal.

In most wattle barks the majority of the parenchyma cells contain tannin but the concentration in individual cells varies greatly. This is reflected in depth of colouration of the precipitate. Barks of low tannin content generally, but not always, contain fewer tannin cells than barks of high content.

In barks from the lower parts of South Eastern Transvaal trees tans were abundant in the cortical and outer phloem parenchyma regions and comparatively scarce in the bast fibre zone. Under the low power of the microscope these two zones were usually sharply diferentiated, the outer being deeply, and the inner, lightly, stained. The tannin content and distribution in bark from a single tree was capable of great variation with vertical position. The following is an example in which sections of bark were taken from the same tree at heights of 5 ft., 12 ft. and 25 ft.

5 Foot.—Tans very abundant in outer parenchyma tissues, every cell being solidly filled with the precipitate. In the bast fibre region tan cells relatively scarce and forming rectangular patterns with ray cells.

12 Foot.—Tannin practically absent in outer parenchyma tissues, only occasional cells containing the brown precipitate. In the fibre tissue

staining was more or less the same as in the 5 ft. section and approximately 50% of the parenchyma cells, scattered at random, were stained. Tannin cells not rectangularly patterned with the ray cells as in 5 ft. section. All ray cells generally filled with brown precipitate.

25 Foot.—Sections of typical appearance again, all showing uniform staining. Tans concentrated in outer portions of the bark and not in the inner as in the case of 12 ft. section. Almost entire absence of parenchyma cells between pericycle and fibre bundle region. Tans most abundant in the cortical tissue to the outside of the pericycle and in the outer part of the fibre region. In the inner part of the fibre region tans were absent except in scattered cells. In general this section was similar to the 5 ft. section except that the parenchyma tissue to the inside of the pericycle was almost absent.

In these bark types with the bulk of the tans concentrated in the the outside part of the bark, the borders between the high and low tannin regions were generally very regular but sometimes wavy or ragged.

(*b*) *North Eastern Transvaal.*

A stringy rather tough bark with an exceptionally high tannin content for its thickness. Only a few samples of dry bark were examined from these regions and from sections it appears that the North Eastern Transvaal bark is similar to that from the Piet Retief area, the high tannin content and fibrous nature being borne out microscopically.

(*c*) *Natal Midlands, Eastern Cape Province and Transkei.*

The bulk of the wattle bark produced in Natal falls in this class. With variations from different localities, it is lower in tannin content than bark from the Eastern Transvaal. Vryheid possibly falls into this group.

The following short description is based on examination of bark from New Hanover and Mid Illovo which is more or less typical for this class.

Under the low power of the microscope the distribution of tannin in the sections presented almost the opposite appearance to those of the Transvaal bark. The bulk of the tans were concentrated towards the inside of the bark. The cortical chlorophyllous cells, with rare exceptions, were completely devoid of tannin. In the phloem parenchyma tissue inside the pericycle, the main tannin containing tissue in Transvaal barks, tannin was almost absent. Only the two or three rows of cells immediately adjoining the pericycle were filled with tannin precipitate. The main tannin containing tissue was in the bast fibre bundle region. Here, too, the tannin cells did not tend to form regular rectangular patterns as in the Transvaal bark but were nearly always closely associated with the fibre bundles around which they generally were. In the fibre region also, tannin cells were more abundant nearer the wood and became less abundant in an opposite direction. The medullary rays contained only a small amount of tannin.

On the whole tans in this group were more evenly distributed across the bark than in Transvaal bark in which they preponderate in the outer tissues.

(*d*) *Harding District and Parts of the Cape Province, particularly in the George District.*

Only a few samples of bark were examined from these regions and found to be of high tannin content but less fibrous than Eastern Transvaal

bark. The bark is also more dusty when ground or chopped, and the dust more astringent and floury to the touch. Tannin precipitate was abundant both in the parenchyma tissue and fibre region with a tendency to preponderate in the former but never so markedly so as in the Transvaal bark.

The above classification could probably be further sub-divided according to soil types, particularly group (*c*). Severe winter frosts and cold also seem to favour production of bark with high tannin content. This is particularly noticeable in the Eastern Transvaal in districts such as Ermelo and Lothair. Here winter frosts and cold are often a limiting factor to wattle production and mortality in young plantations is frequently high. Trees that survive the frost-susceptible stage, however, invariably produce bark with very high tannin content.

Green Wattle Bark.

A considerable number of green wattle (*Acacia decurrens* Willd.) bark sections examined in all structural respects agreed very closely with black wattle. Tan cells were very abundant and the radial distribution on the whole fairly even in the peranchyma and fibre tissues. Occasionally tan cells were more abundant in one or other of these tissues but contrasts were never as marked as in the case of black wattle.

Silver Wattle Bark.

Silver wattle (*Acacia dealbata* Link.) bark is usually smooth in appearance and can generally be distinguished from black or green wattle by its clean fracture attributable to its less fibrous nature. Under the microscope the fibre bundles are generally less abundant and smaller than in black wattle. It is very variable in the number and distribution of tannin cells.

In a number of specimens examined from the Vryheid district the tannin cells were very sparse and it could clearly be seen that the tannin content was very much lower than in black wattle. In these cases tannin cells were almost absent in the parenchyma tissue inside and outside the pericycle. Around each fibre bundle, however, there were generally extremely regular rings of tannin cells, usually one or two cells thick. Further in and close to the wood these rings gave way to a more continuous tannin tissue in which the majority of the parenchyma cells were filled with precipitate. This more or less continuous tannin tissue was narrow and very irregular.

Samples from old trees in the Iswepe area were also examined and presented a very different appearance to the sections described above. The only thing that the two had in common was that the fibre bundles were less abundant than in black wattle. Tans were quite abundant in this bark and from microscopic examination much more so than one would expect from silver wattle. It is quite possible though that these particular samples contained a higher percentage than is normal for the species as the trees were very old and the bark unusually thick. Unfortunately, it was not possible to have them chemically analysed. Tannin was abundantly present in the parenchyma cells and particularly those to the outside of the pericycle. Inside the pericycle, interspersed among the tannin cells, were numerous cells containing no tannin but very large distinct globules. Included globules and starch grains were

sometimes observed in the parenchyma cells of black wattle but never anything like as large or abundant as in these sections. Further in towards the bast fibre region the tannin cells became less abundant and near the wood were almost entirely absent. When they did occur they did so generally in radial and tangential rows forming a roughly rectangular pattern. The parenchyma cell walls in these inner parts of the bark were also very indistinct, swollen and disintegrated, and the cells had the appearance of being scattered about and not forming a continuous tissue.

Java Wattle Bark.

Samples of dried bark were obtained from Java, stained, and examined. Species is unknown but probably *Acacia decurrens* which is extensively grown in Java. The structure of Java wattle bark was typical but tans were never very abundant. The tannin cells themselves were abundant but staining was never very deep and the precipitate was yellower than in black wattle. The walls of the parenchyma cells were also consistently swollen and plumped, a phenomenon which was rarely come across in South African barks examined, and the strips of compressed sieve-tubes in the outer regions of the bark were unusually prominent and longer.

Conclusion

Although it is possible to distinguish microscopically between barks of high and low tannin content, assessment of tannin on a quantitative basis is not possible. With careful laboratory technique and practice it might be possible to estimate the tannin content of a particular section but it can never be hoped to obtain a representative sample from one or even a number of sections. It has been shown that bark at different points along the stem of a tree can vary considerably in tannin content and even sections from the same piece of bark one centimetre square.

In some cases microscopic examination may prove useful especially where it is suspected that a sample contains silver wattle bark which can be distinguished with a high degree of certainty. With practice it might be possible to distinguish between barks from different regions such as Eastern Transvaal and Natal Midlands and between black and green wattle.

Microscopic structure and tannin distribution will probably prove most useful in obtaining a better knowledge of barks from different regions and thus a better basis for the blending of wattle barks without which the miller cannot expect to obtain the best possible results.

No indication of bark colours could be obtained from microscopic examination.

Summary

Microscopic examination of bark sections discloses a systematic distribution of tannin among the various structural elements which differs in some species and in barks from different regions. As a quantitative means of assessing tannin content microscopic examination is of no value.

Acknowledgements

Assistance received during the course of these investigations from Mr. E. A. Goodwin, Government Wattle Bark Inspector, is gratefully acknowledged. Thanks are also due to Drs. McLean and Wager, of the Natal Herbarium, for free access to their laboratory facilities.

References

Williams, C. O.: South African Tanning Materials. Science Bulletin 106, 1943.
Van der Byl, P. A.: The Anatomy of *Acacia Mollissima* Willd. Science Bulletin No. 3, 1914.

A SYSTEMATIC BASIS FOR WOOD-USES RESEARCH

By JOHN M. TURNBULL

(*Forest Products Institute, Pretoria.*)

A RELENTLESS search for woods to replace the peace-time requirements in raw materials of many timber-using industries is proceeding throughout the world. The search at times is exacting because in some instances no clear conception of the requirements concerned has ever been formed. Frequently pre-eminence is claimed for a wood without any justification beyond tradition and availability. An industry may have been initiated in a locality where the wood of a certain species happens to abound and has given passable use. In course of time the association between this wood and its established use becomes traditional. In another wooded locality, the industry may never have been introduced, mainly because trees of the traditional species do not thrive in its woodlands, and transport of wood from an otherwise favourable locality might be expected to impose too heavy a burden on cost of production. Later, perhaps, superior initiative conceives the idea of using a local substitute. An investigator visits the pioneer locality, examines the forests from which the raw material of the local industry derives, inspects factories, observes how the wood stands up to various machining processes, and takes samples away with him to examine and test with greater deliberacy. In due course the outstanding properties of the timber are determined, and timbers of the home woodlands are examined and tested with a view to finding a wood similarly characterised. After considerable trial and error, one is selected, and the industry established in its new home. A hundred per cent. efficiency does not, however, necessarily result, even assuming absolute efficiency in craftmanship and organisation. The wood used in the pioneer factory, not having been in the first place critically selected, may have been far from ideal for the purpose in view, whereas one or more of the woods growng in the new locality, and matching the pioneer wood less faithfully than the selected substitute, might have yielded better results. The investigator's quest has been misdirected. Instead of endeavouring to match a wood, his effort should rather have been focused on analysis of the manufacturing process and determination of the properties appropriate to optimum service in the finished product. Different parts of the product may demand the use of woods of widely different properties. Again, the chief virtue of a traditional wood may be a minor property in relation to other industries, which is met with also in other less valuable woods. In this case wasteful dissipation of a regional resource becomes involved.

If all wooden products or distinctive parts of products could be analysed, and all properties essential to their efficiency and ease of manufacture listed in order of importance, it would be a comparatively easy matter to find woods suitable for any purpose in view. The current method of finding substitute material should be replaced by search for the best woods for particular purposes, and concern about woods already in use relegated to

the background. Such concern is apt to divert attention from what should be the real object.

Organization of Research

To put selection of timbers for specified uses on a systematic basis, a permanent international bureau might be established, to which might be entrusted the task of collecting through its local committees information regarding the principle properties, in order of importance, essential in the manufacture and service of as many wooden products and parts thereof as possible. Local committees might be composed of representatives of well assorted groups of industries, government departments, standards institutions, universities and technical colleges. They should be accorded state recognition, and means should be devised to ensure that they remain active.

All information coming to hand should be transmitted immediately to the central bureau, as, even if incomplete, that body might already be in possession of the complementary information. All information thus transmitted would be digested, queried if necessary, suitably recorded and distributed by the bureau in the form of periodical or special reports to the local committees or to the forest products research laboratories of the contributory states. Each participating authority would compile, as information became available, a list of home-grown species against each of which its properties would be indicated.

Assembly and Application of Data

For the efficient working of the scheme as here outlined, a series of schedules something in the form of those indicated in skeleton form below might be kept. The proposed manner of entry and use of these schedules is described below each.

Schedule A: Uses.

Serial.	Description.	Properties.

On receipt of advice from the bureau regarding the properties desirable in any use, the next available serial in the schedule would be allotted to it, and its description entered in the second column. In the third column would be entered the relevant property serials, obtainable from schedule E. The data would then be repeated in reverse in schedule C as described lower down. If the data happen to be a mere extension of previously received advices, the originally allotted " use " serials would be found from E, and the necessary additions made against them in A and C.

Schedule B: Species.

Serial.	Name.	Properties.

Treatment similar to A, except that this schedule is used in combination with D, instead of with C. The relevant data would mostly become available locally and should be entered immediately on receipt of test results or of advice.

SCHEDULE C: PROPERTIES AND RELEVANT USES.

PROPERTY.		USE SERIALS.											
Serial.	Description.	1	2	3	4	5	6	7	8	—	—	n–1	n

Having entered a " use " in A, serials would next be allotted to any hitherto unrecorded properties that may be relevant, and the unrecorded properties described in column 2. Crosses would then be made in the relevant "use" columns. It is probable that one or more of the properties concerned will have been previously entered in connexion with some use or uses already dealt with. Schedule E will disclose this, and will guide the recorder to their positions in schedule C, against which whatever additional " use " crosses that may be necessary may then be inserted.

SCHEDULE D: PROPERTIES AND RELEVANT SPECIES.

PROPERTY.		SPECIES SERIALS.											
Serial.	Description.	1	2	3	4	5	6	7	8	—	—	n–1	n

Treatment similar to C, but used in conjunction with B, instead of with A.

SCHEDULE E: INDEX.

Use, Species or Property.	Schedule.	Serial.

This schedule is an alphabetical index. It should be compiled as soon as the volume of data available becomes unwieldy. Data becoming available after original compilation may be allowed to accumulate until it also becomes unwieldy, when it should be incorporated. The interval between successive re-compilations might be lengthened by assembling all additions under their respective initials, space being left for this purpose at the end of each thus-far completed letter in the alphabeticization. Re-arrangement might be rendered altogether unnecessary by using a card index, but it is thought such an instrument might prove rather cumbersome for the purpose.

SCHEDULE F: OPERATIONAL.

PROPERTY.													
Serial.	Description.	1	2	3	4	5	6	7	8	—	—	n–1	n

This is the operational schedule. The most convenient manner of keeping it would probably be the scoring of headings and grid on a slate. It will

be noticed that the second primary space at the head is left blank. This is because the form can be used either for fitting a species to a use or *vice versa*. The operator should insert the relevant word in pencil each time the slate is used, and in order to avoid any possibility of confusion it should be rubbed out after each case has been dealt with. Except for this omission, the headings and grid are the same as in C and D, but only such property serials are entered as apply to the case in hand. To fit a species to a use, all properties required in that use, as obtained from C, are set down successively in the first two columns, and in respect of each a cross made under each " use " serial that may apply. The most appropriate uses for the species are indicated by the number of crosses eventually appearing in the individual " uses " columns. Uses are fitted to species by completing the schedule from data reflected in D, instead of in C. About twelve lines should be ample vertical space for all occasions.

Example

The details throughout the example that follows, together with the hypothetical schedule D, should not be critically considered. The example is intended merely to illustrate the proposed method of solving a problem. Woods are required for the manufacture of printers' cutting sticks, which are shewn in schedule A as demanding properties designated, say, by serials 2, 4, 9, 11, 14 and 16. The species conforming to each of these six " properties ", as indicated in the example of schedule D that has been improvised for purposes of illustration, are as follows:—

Property.	*Species.*
2	1, 2, 6, 9, 11, 14, 18, 19
4	7, 9, 11, 18
9	4, 9, 14, 16, 18
11	5, 6, 8, 19
14	5, 9, 10, 14
16	8, 10, 11, 15

This data will appear in the operational schedule F in the manner indicated. All species endowed, in this case, with less than three of the requisite properties may be ignored. This leaves the following species for consideration:—

9: red els;
11: white pear;
14: another;
18: another;

and as the order of importance of the properties, as disclosed by schedule A, is 2, 16, 4, 14, 9 and 11, the position may be set out in yet another schedule, say G, as shewn below. Species 14 and 18, by this shewing,

Schedule G: Order of Imporatnce and Expression.

Property.	Species.			
	9 Red Els.	11 White Pear.	14 Another.	18 Another.
2	x	x	x	x
16	—	x	—	—
4	x	x	—	x
14	x	—	x	—
9	x	—	x	x

SCHEDULE D: PROPERTIES AND RELEVANT SPECIES.

PROPERTY.		SPECIES.																		
Serial.	Description.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Plentiful	x	—	—	—	—	—	—	—	—	—	x	—	—	—	—	x	—	—	—	—
2	Texture fine	x	x	—	—	—	x	—	—	x	—	x	—	—	x	—	—	—	x	x	—
3	Texture open	—	—	x	—	—	—	—	x	—	—	—	—	—	—	x	—	—	—	—	x
4	Straight grained	—	—	—	—	—	—	x	—	x	—	x	—	—	—	—	—	—	x	—	—
5	White	—	x	—	x	—	x	—	—	—	—	x	—	—	—	—	—	—	—	—	—
6	Yellow	—	—	—	—	x	—	—	—	—	—	—	—	—	x	x	—	—	—	—	—
7	Red	—	—	—	—	—	—	—	—	x	—	—	x	—	—	x	—	x	—	—	—
8	SG. ·4 to ·7	—	—	x	x	—	—	—	x	—	x	—	—	—	—	—	—	—	—	—	—
9	SG. ·7 to 1·0	—	—	—	x	—	—	—	—	x	—	—	—	—	x	—	x	—	x	—	—
10	MR. —6,000 lb.	—	—	—	—	—	—	x	—	—	x	—	—	—	x	—	—	—	—	x	—
11	MR. 6,000—10,000 lb.	—	—	—	—	x	x	—	x	—	—	—	—	—	—	—	—	—	—	x	—
12	MR. 10,000—16,000 lb.	—	—	—	—	—	—	—	x	—	—	x	—	—	—	x	—	—	—	—	—
13	MR. over 16,000 lb.	—	x	x	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—
14	Hardness 800—1,200 lb.	—	—	—	—	x	—	—	—	x	x	—	—	—	x	—	—	—	—	—	—
15	Hardness over 1,200 lb.	—	—	—	—	—	x	x	x	—	—	—	—	—	—	—	—	—	—	x	—
16	Non-splitting	—	—	—	—	—	—	—	x	—	x	x	—	—	—	x	—	—	—	—	—
17	Lustrous	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	x	—
18	Dull	—	x	x	x	—	—	—	x	—	x	—	—	—	—	—	—	—	—	—	—
19	Odourless	—	—	—	—	x	—	x	—	—	—	x	—	—	—	—	—	x	—	—	—
20	Scented	x	—	—	—	—	x	—	—	—	—	—	—	x	—	—	—	—	—	—	x

SCHEDULE F: OPERATIONAL.

PROPERTY.		SPECIES.																			
Serial.	Description.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	Texture fine	x	x	—	—	—	x	—	—	x	—	x	—	—	x	—	—	—	x	x	—
4	*Straight grained*	—	—	—	—	—	—	x	—	x	—	x	—	—	—	—	—	—	x	—	—
9	SG. ·7 to 1·0	—	—	—	x	—	—	—	—	x	—	—	—	—	x	—	x	—	x	—	—
11	MR. 6,000 to 10,000	—	—	—	—	x	x	—	x	—	—	—	—	—	—	—	—	—	—	x	—
14	Hardness 800 to 1,200	—	—	—	—	x	—	—	—	x	x	—	—	—	x	—	—	—	—	—	—
16	Non-splitting	—	—	—	—	—	—	—	x	—	x	x	—	—	—	x	—	—	—	—	—
		1	1	—	1	2	2	1	2	4	2	3	—	—	3	1	1	—	3	2	—

are each clearly inferior for the purpose in view to red els and white pear, and may accordingly be ignored. Although red els has one more desired property than white pear, the order in which white pear's occur sets-off the former's superiority in hardness and specific gravity, which are not actually of very much account in the use contemplated, and white pear might therefore accordingly be selected.

Weighting of Properties

If marks could be allotted to denote the relative importance of each property with reference to each use, selection might be determined with greater confidence. A further step forward might be substitution in schedule B of marks for crosses to denote the relative degree to which any property is expressed in the various species.

Negative Characteristics

The local committees who furnish the individual items of information would need to solicit a high degree of co-operation on the part of local industrialists, who should be impressed by them with the necessity of making their reports as explicit as possible. A report to the effect that a certain wood has been used from inception of a local industry, and has given entire satisfaction, is useful, if correct. In some cases, however, while such a wood may be ideal for the purpose of turning out the product a manufacturer may consider satisfactory, its prospective user may have ideas concerning its improvement, which might be secured by substitution of a different wood. The manufacturer, himself, may at times have grumbled about the high cost of maintaining keen edges on his machine tools, due, perhaps, to grittiness in the wood he uses, but as the wood has most of the appropriate properties, has accepted the position as a matter of course, and accordingly fails to report the defect, and thus dissipates an opportunity for effecting improvements. It is most important that all negative characteristics in established woods be reported, and their antitheses recorded in schedule A as desirable positive properties for the use in view.

Variable Woods

Some wood species are suspect in certain industries owing to variability in properties. Protection against this characteristic may be obtained in various ways. Marked uniformity in a species, when it does occur, should be noted in schedules B and D against the species concerned, and should be demanded in A and C. Thus would use of variable woods be avoided. The incidence of variability itself may be lessened by analysis. The chief factors responsible for variability in the wood of a single species are age, environment and radial and longitudinal position in the merchantable stem. Where reaction to one or more of these factors is known, timber of a given species may be split up into groups which may be dealt with in the scheme as though they were actually separate species. Thus, in the hypothetical schedule D, on page 55, species No. 5 might be sub-divided into 5a and 5b, denoting the same species of under and over 20 years growth, respectively. No. 7 might include 7a, 7b and 7c, denoting wood of a given species as grown in the Natal Midlands, in the Transvaal and elsewhere, respectively; and so on, with combinations where found applicable. The categories might be made more specific than here suggested, but much research is still necessary in this direction.

Grading's Place in the Scheme

With variability within species is closely bound up the question of grading. To-day, the grading of softwoods is focused mainly on structural efficiency; hardwoods, on appearance. The development of grading rules is difficult and accordingly slow, and in many countries awaits the spur of urgency. For many purposes urgency has taken the bit in her mouth and leapt all obstacles by means of the development of " improved wood " and wood plastics. These recent developments really amount to impatience with the variability of wood, and determination on the part of certain associated industries to make of wood something better than itself to which almost any species can be made to contribute with a minimisation of the incidence of botanical differentiation. If these aims and the processes necessary to their achievement could be fulfilled within a reasonable period, the demand for natural wood, within that period, might decline to an extent that would considerably reduce the necessity for grading and application of intensive research into wood uses. Even, however, could an *ersatz* wood of absolute homogeneity be developed, special uses would still be dependent on a profile. The highest degree of homogeneity would involve a material having the specific gravity of absolute wood, about 1.6. But such a material would be of no use for life-belts, and at best would be very cumbersome as furniture-making material. Variability in wood products is therefore not necessarily a drawback. One use's poison is another use's meat ,or in the words of Bacon, " the vale best discovereth the hill ". The vales and the hills of wood properties may still constitute a fitting topography for survey by an international bureau of wood-uses research, and how better than by extending the purpose of grading to considerations other than structural efficiency and appearance.

Grading for specialised purposes has hitherto been much neglected. In its development, in relation to the present proposals, arbitrarily applied and quite distinct from fundamental considerations, might be found a solution of the difficulty so far found to be inseparable from such considerations. When logs of variable species are broken down, variations in certain properties, such as density, colour, odour, direction of grain, figure and, say, oiliness can be detected on inspection. Wood so differentiated can be separated out into grades submitting easily to definition, without recourse to research into the causes of the differences, however desirable such research in other respects might be. Their definition might be spared the awful jargon of the British and American softwoods grader, and be confined to mere reference to peculiar properties, or, dependent on the progress of the central bureau's research into wood uses, straightway referred to specialised uses to which they may happen to be peculiarly appropriate. However defined, each such grade, as also existing commercial grades, for purposes of certain of the suggested schedules, should, or might, be regarded as separate species, and dealt with accordingly.

Rectifiable Defects

Woods endowed with a number of properties demanded in certain uses, may be lacking in other important ones, such as durability and strength, which may be susceptible to rectification by artificial means. Such woods should not be ignored on this account without considering whether the absent properties might not economically be imparted by, say, chemical treatment for durability, or appropriate stay design for strength.

Relationship to Perforated Card System

The system described in this paper is closely related to the perforated card system, which has been adapted for use in connexion with the identification of woods;* or rather, the latter is a semi-mechanised form of the former, to which it bears a relationship analogous to that borne by the slide rule to a table of logarithms. The crosses in table F correspond with the punched out perforations of the cards, of which species 9 would have four, so that pins inserted in the 6 relevant perforations would allow this card, with its four open punches, to slip out of the pack. The number of uses concerned would in time, however, become too great to justify adoption of cards, and, even might this limiting factor be eliminated by complete mechanization on the Hollerith principle, the elasticity required for such end considerations as described in the operational example would be lacking.

General

The most important feature of the system would be compilation of the " uses " schedule, A, a matter that could be dealt with most effectively by an international body. The " property " schedule, C, might also be kept up to date by the central bureau. The " species " schedules, B and D, are of more local significance, and it might frequently be desirable to use the locally collected data before it could be registered and incorporated in the bureau's records. It might, nevertheless, be possible to use a local enumeration provisionally which might be closed after the data had been digested and redistributed by the bureau. Descriptions of properties and uses would call for particular care, particularly as regards cross-reference in schedule E. They would call for as brief expression as possible, preferably by single words, provision being made by cross-reference for local usage.

In the example demonstrated and discussed above, schedule D comprised only 20 properties and 20 species. Properties, species and uses might in practice all run into hundreds, particularly when certain properties submitting to numerical evaluation were ranged in classes. Modulus of rupture, for instance, might be grouped into less than 4,000, 4,000-8,000, 8,000-12,000, 12,000-16,000 and over 16,000 pounds, or even more intensively. Where a large range was permissible in a certain use, two or more classes might be pegged in the schedules, but in this case the value of each cross concerned in the relevant coalescence would be subject to division by the number of classes concerned. The system of weighting, discussed briefly higher up, might be extended to provide against such and other contingencies. The detail of the scheme would call for careful consideration by whatever authority might eventually be established to conduct its operations. Such considerations as availability, age, natural habitat and cost, not usually considered as " properties ", might be treated as though they were. Availability, which largely determines cost, would, for expediency's sake, always be a determining consideration, often outweighing that of properties essential in a wood ideal for a specified use.

---

* The Card Sorting Method as Applied to Identification of the Commercial Trees of the Genus *Eucalyptus* by H. E. Dodswell and Andrew M. Eckersley. *I. Coun. Sci. and Ind. Res.* (Aust.) Vol. 14, No. 4. 1941.

While the scheme, as described, is principally applicable to specialised uses, it is of more than academic interest to know what properties should apply to more general uses. The bogey of a timber famine may become a reality to succeeding generations. Man's appetite grows with his increase, and if it's woody satisfaction demand extension of afforestation, it is of vital importance that the species selected for such extension be appropriate to his needs.

If the proposed system be considered sound as regards wood, the possibility of extending its use to include all raw materials will deserve consideration. There are vested interests concerned in every form of production, which tend to restrict free selection of materials in the manufacturing industries. If their influences on demand could be subordinated to free selection on scientific principles, a more healthy system of production and distribution of this world's wealth might result.

Summary

Research on wood-uses has hitherto been focused on comparison of the properties of hitherto unutilised woods with woods already established in specific industries. Establishment, in many cases, it is contended, is purely traditional, and it is suggested that a consideration of first principles replace search for mere substitutes. A method of procedure to this end is described, and its extension to embrace materials other than wood, considered.

CORRESPONDENCE

ANTI-STAIN SOLUTIONS

To the EDITOR

Sir,

In your issue No. 8 of April, 1942, there was an article by Mr. M. H. Scott regarding timber seasoning in South Africa. As you know, we handle Anti-Stain solutions, and on page 74 the remark was made that the protection of timber by these does not last for more than a few months, and that they are of little effect if the timber is not immediately open-stacked to dry out. Naturally, as this was of particular interest to us, we submitted a copy of the article to our suppliers in America, who comment as follows:—

The author, of course, is substantially correct in his statement that the anti-stain solution does not offer protection for more than a few months, but in the seasoning of lumber it is generally true that damage by staining organisms is accomplished within the first few weeks after cutting and the moisture content of the lumber is relatively high. After the lumber is stacked and has seasoned for some time its mosture content is lower than will support life and attack by staining organisms. His statement to the effect that timber must be immediately open stacked to dry out is rather an indefinite one inasmuch as he does not place any limitation on the time element. We recommend that lumber be stacked immediately, but in many cases we know that lumber is bulk piled after dipping for periods of one to three weeks and in the majority of cases control over stain is entirely satisfactory. In many mills lumber is bulk piled for a considerable time after dipping before being kiln dried and the stain treatments offer complete control in these cases during the period of bulk piling.

Stain control chemicals do not preclude the use of proper seasoning methods but rather are an aid to these methods in obtaining bright lumber. These solutions will offer adequate control in a very high percentage of operations but there has been no control method found which will prevent stain under all conditions and especially those associated with poor management and neglect . . .

. . . we assure you that protection over staining offered by these solutions is entirely adequate for the critical period encountered during the seasoning period. Lumber with a low moisture content will not stain and therefore when lumber is processed or in any other way manufactured after being kiln dried or air seasoned, the danger from blue stain is very remote unless the lumber is exposed to the elements for a considerable length of time and is allowed to regain a high moisture content and with no protective covering such as paint or other material.

Yours faithfully,

A. QUIDING & SON.

Our correspondent's letter has been communicated to Mr. Scott, who has kindly favoured us with the following explanation:—

I welcome criticism of this kind. The remarks referred to by Messrs. A. Quiding & Son were of a general nature, referring to no particular anti-stain solution, and were in no way meant to depreciate the value of such dips, which is universally recognised, but rather to emphasise the need for correct seasoning practice, even when dips are used. It is perhaps unfortunate that a reference to the further remarks on anti-stain solutions on page 98 of my article was not included on page 74.

The justness of the criticism now made would seem to depend on what is meant by the word " immediately " in the text of the article. On page 98 under the heading " Discolouration " ,the use of anti-stain solutions is dealt with in greater detail, and it is made clear that dipped boards may be close piled in the ordinary course of sawing and seasoning but should not so be left for any length of time. It is not possible to say generally what the time limit might be, but with our local pines the green moisture content is often over 200 per cent. and under these conditions there is always a danger that the anti-stain solutions may become unduly diluted and their effectiveness consequently reduced.

All that is said in your correspondent's quotation will be found on page 98, but I think that a point which must not be overlooked is that logs coming into the mill are not necessarily free of blueing when they are sawn, and that unless stacked to dry out immediately after dipping, the danger of the infection spreading in the boards is greatly increased.

Fnally I would mention that the folder issued by the proprietors of one of the anti-stain solutions most widely used in this country states, amongst other things, that for best results " dipped lumber be promptly stacked in piles with plenty of air circulation provided ".

Reprinted from the
Journal of the South African Forestry Association
No. 1, October, 1938

HISTORICAL SKETCH OF THE DEVELOPMENT OF FORESTRY IN SOUTH AFRICA.

By N. L. KING

(Chief Management Officer, Division of Forestry)

WITH the first issue of our Journal it is fitting that a sketch of the development of forestry in South Africa should be presented and a tribute paid to the pioneers who, in the face of great difficulties, laid the foundations on which the forest service of the Union of South Africa has been built and who did so much to further the cause of forestry. In order to obtain a proper perspective of the development of the service, it is first necessary to say a few words about the natural timber resources of the country.

The greater part of South Africa is, in the word of Max O'Rell, "scarcely more clothed than the natives who inhabit it." The timber forests, exclusive of the widely scattered cedars on the Cedarbergen, scrubs, savannahs and the bush-veld of the Transvaal, are confined to the well-watered strip commencing near George, and extending Eastwards and North Eastwards for a distance of 1,000 miles into the North East Transvaal. The largest and best known are those in the George-Knysna-Tzitzikama area where, on the narrow shelf hemmed in on one side by the lofty Outeniqua and Tzitzikama mountains and on the other by the sea, the forested area aggregates 112,000 acres, of which 90,000 acres belong to the State and the remainder to private persons. These forests peter out at Clarkson where the Tzitzikama mountains disappear into the sea.

From there Eastwards only scrub and an inferior type of forest are met with until the mountains above Fort Beaufort are reached. Between this point and Stutterheim some very fine forests occur particularly near Hogsback and in the vicinity of Stutterheim. A few miles east of Stutterheim forests give way to thorn veld and scrub and reappear on the mountains above Engcobo. From this point small patches, some of which are of very high quality, occur right along the escarpment through East Griqualand, Natal and Zululand. In this long strip along the mountains from Fort Beaufort to Zululand nearly all the forests remain in possession of the State but aggregate only round about 150,000 acres.

Forests are again met with on the escarpment overlooking the low veld in the Eastern and North Eastern Transvaal. The total extent is however, estimated to be not more than about 6,000 acres. About 90,000 acres of forest also occur at intervals along the coast from Alexandria eastwards. Speaking generally these coast forests are not nearly so valuable as those on the mountains. Here and there they reach a high quality as for example at Manubie and Mpame in the Kentani and Elliotdale districts and at Ntsubane in Eastern Pondoland.

From this brief sketch it will be seen that the total extent of timber producing forests in possession of the Crown is only a matter of 336,000 acres scattered over a very wide area.

It has been the case the world over that until forest services have been built up forests have suffered as a result of European occupation of new territories. In this respect South Africa is no exception to the rule. When settlers landed at the Cape in 1652, timber was one of their first requirements for housebuilding and other purposes, and, as would be expected, supplies were drawn from the small forests that existed there at the time. As European penetration extended Eastwards and gradual annexation of the country took place, the forests right into the Transvaal were laid under tribute.

Beyond a few placaats prohibiting the cutting of trees in certain areas the Dutch East India Company took no active steps to conserve the forests and for more than half a century after the Cape was ceded to Britain in 1806 matters were no better. The forests were virtually under the control of Landrosts or Civil Commissioners who, with a few exceptions, merely issued licences to woodcutters who cut where they liked, what they liked and as much as they liked.

In the George-Knysna area so much destruction took place that in 1846 the Governor decided to close the forests against further cutting, but naively added that in order not to inconvenience the timber trade the forests would be surveyed into lots for sale by public auction. Fortunately before many of the lots had been sold the Cape was granted a free constitution and one of the first acts of Parliament was to appoint a Commission to enquire into the expediency of selling the forests. The Commission reported against further sales except some forest of an inferior type near Uitenhage. The idea was toyed with on later occasions but better councils prevailed.

When the forests were closed in 1847 a Conservator of Forests (Mr. Haswell) and four Rangers were appointed to prevent further depredations.

The forests were re-opened in 1856. An additional Conservator was then deemed necessary to take charge of the Tzitzikama-Uitenhage area. This post was filled by Captain C. Harison, an ex army officer who established his headquarters at Wit Els Bosch, which, at that time, was completely in the wilds. Although Captain Harison had had no forest training he showed remarkable aptitude for his adopted profession. He initiated the idea of working the forests in sections in order to maintain better control over woodcutters and thus prevent unnecessary waste. He also strenuously opposed the alienation of Crown Forests and it was largely due to his untiring efforts that they were not disposed of.

About this time Dr. Pappe, the Colonial Botanist, made a tour as far as Uitenhage and as a result of the forest destruction that came to his notice, he entered the lists to champion the cause of forestry. He died in 1862 and was succeeded by Dr. J. Croumbie

Brown, whose enthusiasm and vigorous style of writing were invaluable in focusing attention on the forests and the need of preserving them for their direct and indirect value. It is not known definitely but it was probably due to his appeal to put a stop to the abuses that were taking place in the Amatola forests that Captain Baron de Fin was appointed Conservator of Forests at Keiskama Hoek shortly after the annexation of Kaffraria in 1865. Although the Baron does not appear to have been of anywhere near the same calibre as Captain Harison, the fact of having a forest officer on the spot must have had a deterrent effect on the reckless felling that was taking place.

These three appointments may be said to have been the beginning of the forest service.

In 1872 the Cape obtained responsible Government and control of the forests was vested in the Commissioner of Crown Lands and Public Works. Three years later the late Mr. J. Storr Lister of the Indian Forest Service was appointed as Superintendent of Plantations at Cape Town and was destined to play a most important role in the development of the Department. Up to that time all that had been attempted was to maintain control over woodcutting in the indigenous forests. Lister soon realised the need of plantations to supplement the meagre natural timber resources of the country. To what extent this view has been justified will be shown later. One of the first steps taken by him was to establish a plantation of quick growing Eucalypts at Worcester to provide fuel for railway locomotives. A few years later he started plantations at Tokai and Kluitjes Kraal. It is of interest to note that among the trees first planted at Tokai were some *Pinus insignis* raised from seed collected in the botanic gardens at Cape Town. This tree, as is generally known, has become of major importance in the Western and S.W. districts of the Cape Province and on the Amatola mountains in Kaffraria.

In 1877 Lister formulated a scheme to reclaim the drift sands at Belville which were a continual source of trouble to the railway line and main road. His scheme was to spread town refuse on the sands and then sow seeds of *Acacia cyclopis* and *Ac. saligna* to establish a permanent cover of trees. The method proved entirely successful and has converted a barren waste into a valuable asset which yields a steady revenue from the sale of fuel and will no doubt in course of time become of great value for building and industrial sites.

Government now began to take a more lively interest in forestry matters and in 1880 voted the salary of the first Superintendent of Woods and Forests. During the following year the office was conferred on Count de Vasselot de Regné, an eminent French Forest Officer, whose services were obtained to examine and prescribe broad principles for the management of the indigenous forests. The principles he laid down have formed the basis on which the forests have since been managed. It has, however, been found that the regeneration methods prescribed by him have not come up to expectations and greater attention is now being paid to this aspect of management.

The late Sir David Hutchins, also of the Indian Forest Service, joined the Cape forest service in 1882 and was appointed Conservator of Forests at Kingwilliamstown in succession to Baron de Fin. Hutchins was possessed of boundless energy and enthusiasm. He vigorously tackled the question of reckless felling in the Amatola forests and in a short time had the sawyers well in hand. They soon found that they could no longer do as they liked and some trekked away into the Transkei where they thought they would have greater liberty of action but as we shall see later this respite was short-lived. He also set about the reservation of forests and grasslands which he foresaw would be needed for afforestation at a later date, and accordingly beaconed the ground he wished to have reserved. This provisional reservation was gone into by a Commission, appointed for the purpose and the reserves as finally decided upon were subsequently declared demarcated forests. Hutchins, like Lister, was an ardent advocate of afforestation and started plantations at Kologha, Isidenge, Hogsback, Katberg and elsewhere. As funds for the purpose were difficult to obtain he tried the Indian taungya system, under which the trees are planted by natives in return for the privilege of cultivating field crops between the rows, but it did not prove a success and was later abandoned. The plantations he started have since been considerably extended and now form a valuable asset.

The year 1888 was, in several respects, an important milestone in the history of the forest service. One notable event was the passing of the Cape Forest Act 28, which conferred on forest officers powers that had long been needed. This Act, with a minor amendment in 1902, remained in force until after Union, when it was superseded by Act 16 of 1913. During the same year control of forests was extended to the Transkei which was annexed between 1878 and 1886 and was later extended to Pondoland which was brought under the Crown in 1894.

The Transkei contained many valuable forests particularly on the mountains. They suffered grievous injury at the hands of natives who cut millions of saplings every year for hut building. Extensive damage was also being caused by sawyers who had migrated from Kaffraria to escape the forest regulations. The threatened destruction of the forests was brought to the notice of Government and as a result the late Mr. C. C. Henkel and some rangers were appointed in the Transkei. Henkel's first task was to reserve the more important forests and then to introduce the same system of management as in Kaffraria. He retired in 1898 and was succeeded by the late Mr. A. W. Heywood. The latter quickly perceived that in order gradually to wean the natives from the forests the first step was to meet their wood requirements from some other source. He accordingly inaugurated the policy of establishing wattle plantations throughout the territories. These plantations have been of inestimable value. They have not only made wood much more easily accessible to natives, but have been the means of preventing an enormous amount of destruction that would otherwise have taken place in the forests. It may safely be said that had these plantations not been established many forests would have disappeared long ago. We

are, however, now entering a new phase. Wattle and daub huts are giving way to better types of buildings. As a result of the general advancement that is taking place there is little doubt that in a few decades the natives will require large quantities of sawn timber for construction purposes and cheap furniture. To meet this prospective demand, plantations of suitable coniferous species are being established as rapidly as funds will permit.

The third outstanding event of 1888 was a rearrangement of staff under which Lister succeeded Hutchins at Kingwilliamstown. The latter took over the Knysna Conservancy and Captain Harison was transferred to Tokai. Shortly after Lister assumed duty at Kingwilliamstown he was asked to formulate a scheme for the reclamation of the drift sands at Port Elizabeth which were not only advancing towards the town, but threatening to silt up the harbour. For seventeen years the Harbour Board had vainly attempted to arrest their advance and after spending £34,000 on the work estimated the cost of reclamation at nearly a quarter of a million sterling. Lister proposed to use the same methods he had employed at Bellville and estimated that the sands could be reclaimed in 16 years at a cost of £51,480. Operations under the control of the forest service actually began in 1893 and in the prescribed time of 16 years the main drift measuring about 11,500 acres had been reclaimed at a cost of £61,000. The credit for the success of the work is mainly due to Mr. E. B. Dwyer under whose able administration it was carried out. Since reclamation was completed the plantation has become an important source of fuel supply for Port Elizabeth and brings in a steady revenue. At the end of 1936-37 maintenance charges had increased the total cost to £94,165 but against this £54,208 has been derived as revenue, leaving the nett cost at £39,957, which is much more than covered by the enhanced value of the land.

On the retirement of Count de Vasselot in 1891 his post was not filled and for 14 years the forest service was without an administrative head. Each Conservator became directly responsible to the Commissioner of Crown Lands and Public Works and later to other ministers of the Crown.

Worcester plantation, which was established in 1876-78 was sold to de Beers in 1892-4 and realised a nett profit of £4,338 or roughly £60 per acre. The financial success of this plantation gave an enormous stimulus to treeplanting both by Government and private enterprise.

Government now began to give consideration to the question of training men for the forest service and in 1892 put into operation a Resolution passed by Parliament 10 years previously that South Africans be sent to the Forest School at Coopers Hill. The first one selected was Mr. C. McNaughton who later became Conservator of Forests at Knysna. Others were Messrs. Dormehl, Carlson, Henkel and Burton. The arrangement terminated in 1906 when a Forest School was started in South Africa.

Shortly after the termination of the Boer war in 1902 the Transvaal, Orange Free State and Natal asked the Cape forest service

for the loan of two men to investigate and report on the subject of forestry within their respective territories. Lister was selected to report on Natal and the Orange Free State and Hutchins on the Transvaal.

The Natal forests had previously been inspected by Mr. (now Dr.) Fourcade in 1889. In a very able report he strongly recommended that the forests which still remained in possession of the Crown should be demarcated and that a Forest Department should be created. These recommendations were given effect to and a German Forest Officer, named Schöpslin, was appointed in 1891. His tenure of office was, however, very short lived and after he left matters were allowed to drift. Lister found the forests in a deplorable condition. On his advice a Forest Service was once more created and the late Dr. (then Mr.) T. R. Sim, author of "The Forests and Forest Flora of Cape Colony" and other works of a botanical nature, was appointed Conservator in 1903. Before he could accomplish much the post was abolished and he himself retired in 1909. Forestry matters were then placed under the Agricultural Department but no progress was made until Union took place in 1910.

The Orange Free State is practically devoid of indigenous trees and for this reason the need of trees to relieve the bareness and to provide shelter and ornament is strongly emphasised. Lister recommended that small plantations be established at various centres in order to try out exotic species likely to thrive. He also recommended that the work should be put in charge of a trained man and suggested that Mr. K. A. Carlson should be appointed as Conservator with headquarters at Bloemfontein. These recommendations were accepted and Carlson assumed duty in 1903.

The plantations established on Lister's recommendations have demonstrated that trees can be grown in the Orange Free State and what has since been accomplished by farmers and others has done much to ameliorate the bleak appearance of this area.

Hutchins found that the forests in the Transvaal had been worked out and strongly urged that plantations be established. He also recommended that a forest service should be organised. The recommendations were acted upon and in 1903 Mr. C. E. Legat was taken over from the Cape and placed in charge of the Department with the title of Chief Forester.

Hutchins, who had made a careful study of trees likely to succeed in South Africa, expressed the view that as climatic conditions in Mexico are very similar to those of the high veld of the Transvaal, Mexican Pines would probably succeed. Seeds of various species were subsequently obtained of which *Pinus patula* is a notable example and has become of major importance in the summer rainfall area of South Africa.

After a lapse of 14 years the Cape Government again considered the forest service of sufficient importance to warrant the appointment of an administrative head and in 1905 appointed Lister to the post with the title of Chief Conservator of Forests. Mr. (now Colonel) Clayton who was selected by Lister as chief clerk was of the greatest assistance in building up the new Department.

Hutchins who felt somewhat aggrieved at Lister's promotion retired during the following year after 24 years of strenuous service.

Shortly after his appointment as Chief Conservator, Lister established a Forest School for the training of men for the higher grades of the forest service. This school, supported by the Cape and neighbouring States, was run in conjunction with the South African College. It was inaugurated in 1906 and functioned until 1911. Several men now holding prominent positions in the service, including the present Director, received their forestry training at this school. It was closed down as a result of a conference with the Minister and Forest Officers shortly after Union. This conference decided that for the higher grades of the field staff the forest service should draw qualified officers from the Oxford School of Forestry, preference being given to Rhodes' scholars from South Africa. This arrangement held good for a few years only. Nominations were then given to students to proceed overseas for study at approved schools and this in turn was superseded by the establishment of a Forest School at Stellenbosch in 1932.

After the closure of the original South African School of Forestry in 1911 consideration was given to the question of training of men for the lower grades of the Forest service. The scheme took shape and in 1912 a school for this purpose was started at Tokai. It is still functioning except that the seat was transferred to Saasveld near George in 1932.

One of the questions that arose at the time of Union in 1910 was whether the forest services should be placed under the central government or handed over to the respective provincial administrations. Although certain Provincial authorities strove hard to obtain control of forestry their claims were rejected on the grounds that the suggested arrangement would probably not ensure continuity of action and uniformity of policy. The next question that arose was the appointment of a head. Lister who had priority of claim, was selected and became the first Chief Conservator of the Union. He held this position until 1913 when he retired after 38 years of distinguished service. As an indication of the esteem in which he was held by the Prime Minister, the late Gen. Botha, his services were extended beyond retirement age.

Lister was succeeded by Legat. One of the first questions with which the latter had to deal was that of the woodcutters in the George-Knysna-Tzitzikama area where a considerable population, dependent almost entirely upon the forests, had grown up. With a view to preventing any further increase in the number of woodcutters powers were obtained under the Forest Act of 1913 to restrict woodcutting to those who were actually engaged in the occupation at that time. Boards were set up under the chairmanship of Magistrates to draw up a list, to which no more names could be added, of those entitled to be registered as woodcutters. This had the immediate effect of restricting the number of sawyers and preventing any additional burdens being placed on the forests. Since then the drain upon the forests has gradually been reduced and must ultimately disappear.

The Great War which broke out in 1914 brought about an acute shortage of timber in South Africa. To assist in relieving this shortage the large *Pinus insignis* trees at Tokai were disposed of during 1918 and 1919 and yielded 734,450 cubic feet of timber which realised £64,905 for the 169 acres. It is of interest to note that the largest tree measured was 136 feet in height, 38.2 inches in diameter at breast height, over bark, and contained 315 cubic feet of timber. As in the case of Worcester plantation this sale aroused enormous interest in forestry and also demonstrated, in a practical manner, that exotic conifers can successfully be grown to maturity. Shortly after the termination of war, it was felt that, in addition to the Research section which was started in 1913, an officer should be appointed to investigate the properties of local woods and the methods of seasoning and preservative treatment of timber. The choice fell upon Mr. Nils B. Eckbo who had been trained in forestry at Yale and had later specialised at Madison in the work he is now doing. From a small beginning made in 1919 with a couple of experimental seasoning kilns at the Pretoria Railway Workshops, the present Institute at Pretoria West has emerged. The work carried out is more of a practical than an academic nature and deals more particularly with the commercial uses to which woods can be put. It has also proved invaluable in training key men to take charge of preservative and seasoning plants which have been established in various parts of the country.

In 1916 Government took a decision which had far reaching effects on the Forest Department. This was the employment of Europeans as forest labourers. The policy was first carried into effect at La Motte near French Hoek, and has since been extended to other parts of the Cape Province and to Natal and the Transvaal. The large sums of money placed at the disposal of the Department in connection with the scheme has resulted in an enormous acceleration in the rate of afforestation. As an indication of the rate of acceleration it may be mentioned that out of the 339,242 acres afforested at the end of March, 1938, no less than 245,842 acres were dealt with during the 16 years from 1922-23 to 1937-38. This rapid extension has not only called for a greatly increased staff but has given rise to problems of management and utilisation which will be referred to later.

In 1931 Legat retired and was succeeded by an administrative officer, Dr. F. E. Geldenhuys. This arrangement existed until 1934 when the Department was incorporated as a division in the Department of Agriculture and Forestry, under the direction of Mr. J. D. Keet.

This briefly is a sketch of the development of forestry in South Africa. From the appointment in 1847 of a Conservator and a few Rangers whose sole duty consisted in checking depredations in indigenous forests, the forest service now controls over 3,000,000 acres of land and has a staff of 71 technical officers, 228 Foresters, 400 foremen and forest guards and 69 men in the clerical division, besides employing about 7,000 European, coloured and native labourers. Employment is also given to about 5,000 men who are engaged in woodcutting and in saw mills and factories which depend upon plantations for saw material.

Let us now turn from the personal element and briefly consider what the forest service has achieved.

The early pioneers after attempting to propagate indigenous trees soon realised that to create timber plantations the only course was to use suitable species from other countries. They were however faced with the difficulty of finding species that would thrive under South African conditions and had perforce to try out a large number and eliminate those which showed little or no promise. Methods of soil preparation, planting distances and other matters of technique had to be learned by experience. It is therefore remarkable that, in spite of many difficulties, such outstanding success should have been achieved. In this connection it can fairly be claimed that South African foresters stand second to none in fitting species to different localities.

By a process of gradual elimination, the main coniferous timber species now in use have been reduced to the following :—

In Western Cape Province: *P. insignis, P. pinaster* and *P. canariensis.*

In Southern Cape Province: *P. pinaster, P. insignis, P. caribaea* and *P. canariensis.*

Eastern Cape Province: *P. insignis, P. patula, P. canariensis, P. caribaea, P. longifolia* and *P. taeda.*

Transkei: *P. patula, P. longifolia, P. caribaea, P. canariensis* and *P. taeda.*

Natal, Zululand and Transvaal: *P. patula, P. longifolia, P. caribaea, P. taeda* and *P. palustris.*

Other species which are doing well in the summer rainfall area are *P. teocote* and *P. insularis.* In addition to the Pines, Cypress, Cryptomeria and Deodar are grown where conditions are suitable. Experimental work is still being carried on to try out new species that are likely to prove useful additions.

From the small beginning made at Worcester in 1877 the area afforested has reached 339,242 acres and sufficient ground is available for planting a further 300,000 acres. It is hoped ultimately to reach 1,000,000 acres if suitable ground can be acquired at a reasonable price. Roughly 238,000 acres of the afforested area consists of coniferous species of which 65,706 acres are represented by *Pinus pinaster,* 38,837 acres by *P. patula,* 25,491 acres by *P. longifolia,* 20,165 acres by *P. taeda,* 17,839 by *P. caribaea,* 13,948 acres by *P. canariensis* and the remainder by other Pines and various members of the conifer family.

Hardwoods are represented by 50,220 acres of Eucalypts; 25,378 acres of *Acacia cyclopis,* and *A. saligna,* used for drift sand reclamation; 12,809 acres of tan wattles (*Acacia mollisima* and *A. decurrens*) and the balance of other species.

The policy that is now being followed in regard to Eucalypts is to restrict their use to fire-belts and gradually to reduce the area of existing stands by regenerating to conifers compartments that are clear felled from time to time. This policy has been dictated by the fact that, owing to their exacting nature, Eucalypts can profitably

be grown to large dimensions only on specially selected sites and for the further reason that the market for mining poles is likely to be fully catered for by private growers. The area under tan wattle is also being reduced except in the Transkei where the main object of wattle plantations is the production of wood for the natives.

How far the policy of artificial afforestation has been justified will be appreciated from the fact that the yield of indigenous timbers which was never more than about 1,000,000 cubic feet a year has been steadily diminishing and now amounts to only 370,000 cubic feet. On the other hand the yield of saw timber from plantations is steadily increasing and at present amounts to about 8,500,000 cubic feet a year. As younger plantations come into bearing the yield will be considerable higher.

As already stated, the rapid rate of afforestation particularly since 1922-23 has given rise to problems of management and utilization. Plantations, each several thousand acres in extent, which have been established in the short space of 10 or 12 years are obviously abnormal as far as age classes are concerned. We are thus faced not only with the problem of establishing normality, without undue sacrifice, in the first or second rotation, but also of utilising the large quantities of wood that have suddenly become available from thinnings. Working plans officers are actively engaged on the preparation of working plans which lay down the general principles of management and provide useful data as to the quantity of wood available during the first five-year period. From the data thus obtained definite quantities of wood can be offered for sale, and, so far, the results have been encouraging in every way. With assured supplies guaranteed under contracts for 5-year periods, with the option of renewal, twelve privately owned sawmills are now operating on plantation grown wood in various parts of the country. These mills which absorb about 1,400,000 cubic feet of timber a year are concentrating mainly on the production of industrial and fruit boxes. At the point where private enterprise fails to take up supplies that may be available the utilization section steps in to handle the timber Departmentally. This section is at present responsible for two State sawmills which manufacture mainly small-sized building material and in this way handle roughly 900,000 cubic feet a year. They are intended to serve as models for layout and to demonstrate in a practical manner methods of seasoning the wood and the uses to which it can be put in order to lead the way for private enterprise.

It is not so much the want of capital that deters private persons from entering the sawmilling business as the dearth of men trained to and experienced in the erection and operation of mills for conversion of round timber into manufactured products. This is due to the fact that hitherto sawmilling has not entered the industrial life of South Africa except on a very small scale in connection with indigenous timbers. An organisation to deal with plantation wood has thus to be built up. If sufficient response is not forthcoming from private persons it is probable that State enterprise will have to be considerably extended to handle the wood that is becoming available.

In addition to the sawing of timber much has been done in the development of markets for round timber treated at preservative plants. In this way considerable quantities of wood are being disposed of for electric transmission, telephone, and fencing poles, half round palings, vine trellises and other commodities.

Apart from its direct functions, the forest service is charged with the protection of over 2,000,000 acres of water-catchment areas. It is also actively engaged in the protection of sea bush to guard against the danger of drift sand and directly or indirectly in the reclamation of drift sands that have been started. The total area of drift sand within the Union is estimated at 92,315 acres of which 17,740 acres are situated on forest reserves or Crown land and the remainder on private property, commonages and native locations. Up to the end of March, 1938, over 27,000 acres of barren wastes of sand have been converted by the forest service into valuable assets to the State.

For the benefit of the wattle bark industry a large amount of research work has been done in promoting correct cultural methods. This work has been the means of putting the industry on a much sounder sylvicultural basis with corresponding financial benefits.

Encouragement in treeplanting has also been given to farmers and others by treeplanting competitions, by advisory work in all parts of the country and by supplying transplants at cheap rates. As an indication of the extent of the latter it may be mentioned that about 4,000,000 plants are supplied to the public annually.

Conservation in its wildest sense has always been the key note of the forest service. The reservation of indigenous forests for State purposes is due to the efforts made by forest officers and the protection of these forests has received special attention. Long before the public began to take an interest in the preservation of flora the forest service was doing so in an unobtrusive way by creating nature reserves in which no cutting of wood, gathering of flowers or shooting is permitted. Sanctuaries have also been set aside where game birds and animals may rest and multiply. Had it not been for the protection thus afforded all game in the Transkei and other native areas would have been exterminated long ago.

The activities of the forestry division, once the Cinderella of the public service, are expanding year by year and with its growth new sections comprising management, utilisation, research and timber investigations have become necessary to deal with the many technical questions that arise from time to time.

Let us now briefly refer to a few outstanding examples of treeplanting by private persons.

In this connection the name of Simon van der Stel, Governor of the Cape, will long be associated with the oaks planted under his direction and which have contributed so largely to the charm of many old homesteads in the Cape. Coming to a much later date, mention should be made of the late Messrs. Arderne and C. J. Rhodes. The former, who was not only an enthusiastic gardener but a keen arboriculturist, introduced many trees and shrubs into his beautiful estate, the Hill, at Claremont, portion of which has now been taken over by the Cape Town Municipality. Rhodes was also

a lover of trees and did much to beautify his estate at Groot Schuur, which is now the official residence of the Prime Minister of the Union. In Natal an outstanding example is the estate called Benvie on the Karkloof, to which the late Mr. Geike retired about 1870 and devoted himself to gardening and treeplanting. Here may be seen azaleas and rhododendrons second to none in South Africa and a wealth of trees from many parts of the world. Mention should also be made of the work carried out by the late Mr. Newberry at Clocolan in the Orange Free State and by the late Sir Lionel Phillips on his estate near Tzaneen in the Transvaal.

Botanic gardens established by Municipalities throughout the country, have done much to foster treeplanting by practical demonstration of species suitable for different areas.

We cannot pass on without a reference to some *Pinus longifolia* trees planted by the late Mr. Garcia, Civil Commissioner of Fort Beaufort, about 1882 in burnt out forest on the Katberg. In those days plants were difficult to obtain and successfully to transport them from Grahamstown—about 90 miles—by ox wagon, was no mean feat. Many of the trees planted were killed by subsequent fires but of those which have survived, some have reached a height of 80 feet and a girth of 8 feet 5 inches and stand as a living monument to the planter.

In commercial tree planting by private enterprise, the most outstanding examples are the wattle bark and mining timber industries, both of which have grown to large dimensions. Black Wattle is said to have first been introduced about 1870 by John Vanderplank of Camperdown, Natal. In 1884 Sir George Sutton exported 11 tons of bark to Great Britain. From this humble beginning the export of bark and extract has developed into a major industry. Today about 500,000 acres are under wattles, of which 72 per cent. is in Natal. Annual exports have risen to over 60,000 tons of bark and 40,000 tons of extract valued at more than a million sterling. In addition to bark, the wattle plantations supply a large number of poles to the gold mines on the Rand.

The discovery of gold on the Witwatersrand was followed almost immediately by a demand for mining timber. Some shrewd business men established plantations of Eucalypts in the vicinity of Johannesburg to meet this demand. Gradually plantations for the same purpose were established further and further afield and today large quantities of mining timber are supplied from the Eastern and Northern Transvaal and from places as far distant as Zululand. The extent of the industry will be appreciated from the fact that during 1937 the gold mines purchased roughly 24,000,000 cubic feet of poles, lagging and mat packs valued at £1,341,821. It may safely be said that, had plantation wood not been available, the country would have been denuded of its natural tree growth, large quantities of mining timber would have had to be imported at high cost and probably low grade mines would have been forced to close down.

Following the lead given by the forest service, private enterprise is now giving serious attention to the cultivation of softwoods. Appreciable progress in this direction has already been made in the Eastern Transvaal and elsewhere.

Finally it may be of interest to sum up the meaning of forestry to South Africa.

The country, at the present time, imports about 28,000,000 cubic feet of building timber a year valued at roughly £2,400,000 and large quantities of boxwood. The forest service aims at making the State independent, as far as possible, of these imports and thus retain and circulate the money which would otherwise be sent overseas. It is not likely that South Africa will ever become entirely independent of timber imports, but our locally grown wood will go a long way in this direction. We already have 238,000 acres of coniferous plantations and, even if no more land is purchased, sufficient ground is available to extend the area to 500,000 acres.

Assuming that the present rate of afforestation is maintained for the next 25 to 30 years, the annual wood increment will then be in the neighbourhood of 60-70,000,000 cubic feet. As utilisation will have to keep pace with increment the conversion of this vast volume of wood into lumber or other products will involve the erection of at least 100 saw mills and possibly pulp mills as well. Employment will then be given to many thousands of persons in felling and transporting the wood to the mills and in the mills themselves. In case of war, South Africa would no longer have to fear a timber famine as was the case during the Great War. At a conservative estimate of 2½d. per cubic foot standing, the State will derive an annual revenue of over half a million sterling from the sale of timber. If reckoned in terms of manufactured products valued at 2/6 per cubic foot after allowing a wastage of 60 per cent. on round timber the value of the industry will be over £3,000,000 a year. If we add the value of hardwoods from both State and private plantations, the total future value of the timber and wattle bark industries may conservatively be estimated at over £5,000,000 a year.

It may thus definitely be said that forestry by the State and private enterprise is building up a great national industry.

L.S.G.

Reprinted from the
Journal of the South African Forestry Association
No. 1, October, 1938

THE RAISING OF TRANSPLANTS OF INDIGENOUS TREE SPECIES FOR OPEN-ROOTED PLANTING.

By F. S. LAUGHTON
(*Senior Forest Research Officer, Knysna, C.P.*)

Introduction.

NURSERY investigations of indigenous species in the Knysna region tend to be complicated by the irregularity of seed-years and the consequent difficulty of obtaining even a few seeds for experimental purposes during years in which heavy crops of seed are not borne. These notes are thus of necessity confined to a limited number of species.

It has always been necessary to supplement the plants raised from seed at Deepwalls with seedlings removed from the forest, and this will presumably be the case wherever a large number of transplants is required. It is undoubtedly desirable, however, to raise stocks from seed rather than obtain them from the forest, whenever possible, both because it is difficult to remove seedlings from the forest without injuring their roots, and because many seedlings become so seriously suppressed under natural conditions that their subsequent growth is impaired for a long period. If seedlings must be taken from the forests, it is advisable to use only those which still carry their cotyledons or their primary leaves.

The present note makes no claim to cover all conditions, as the latter may vary so considerably from those at Deepwalls that some modifications in nursery practice will be required. The methods in use at Deepwalls have, however, been built up on the basis of fourteen years' experience and may be claimed to be successful in that a high percentage of transplants are grown from 2 to 3 inches in height to as many feet in a comparatively short space of time, while the general health of the nursery stock is excellent.

Selection of Nursery Sites.

There are three types of nurseries at Deepwalls, which may be described as follows:—

(a) *Seed Beds.* The local forest soils derived from Table Mountain sandstone and situated on northerly or westerly aspects, where the slope is sufficient to ensure good drainage, are usually light and sandy, though frequently shallow over a compact humus loam or over rock. On other aspects, however, and where drainage is poor owing to the lack of slope, or to seepage from higher slopes, the soils are usually clayey over definitely clay sub-soils. The sandy soils on northerly aspects are, therefore, preferable for seed-bed purposes.

The beds are made along the contour, about three feet wide, so that they can be weeded and tended from the lower side without

excessive bending. About 9 inches of sandy soil on the beds is sufficient for all purposes. It is necessary to revet the lower side of the bed to prevent the soil from falling or being washed away. This can easily be done with spars from thinnings.

At Deepwalls the seed-beds are kept screened continuously in order to afford shelter to the germinating seedlings, and to prevent insolation and excessive evaporation. The screens are made of 'onderbos' (*Trichocladus*) laths or eucalypt coppice about an inch in diameter, tied together about half an inch apart with tarred rope. Eucalypt coppice is probably preferable on account of the straightness of the shoots. The screens are supported on plain fencing wire about 3 feet above the level of the bed.

On account of their high humus content, even these light, sandy soils soon tend to cake on the surface and, as the germination of most indigenous species is considerably delayed and spread over a long period, this should be avoided. It is usual, therefore, to sow the seed on the surface of the freshly loosened soil and then to cover it to a depth of about an inch with mulch from the forest. This mulching greatly reduces the amount of weeding required and tends to keep the soil constantly moist, a condition which is found to encourage the germination of the seed of several species. The seed of other species is best sown in drills about an inch wide and half an inch deep, and covered with river sand. The drills may be made by pressing a lath of the desired size into the soil. This is more satisfactory than attempting to use, on these very light soils, a light wooden roller, on to which laths have been nailed at the required distance apart.

(b) *Transplant Beds.* Nursery stock at least three years old is required for planting out in the forest, as areas to be regenerated are almost always densely clad in fast-growing weeds, so that transplants at least two feet high are needed. At Deepwalls the seedlings are therefore lined out in central nurseries for one or two years, and are then sent out for another year or two to field nurseries near the sites where they will be required. In the field nurseries the transplants receive the minimum of attention, so as to harden them off to withstand the conditions to which they will be subjected.

As deep, sandy soils are unsuitable for the encouragement of those bushy root-systems necessary for field plantings, especially on shallow soils, southerly or south-easterly aspects, where a few inches of fairly light humus-loam overlie heavy clays, are chosen for transplant beds at Deepwalls. Beds are made in the same way as that described for seed beds. Before the terraces are constructed, the light, surface soil is removed and sieved to free it of roots, and it is then replaced on the completed terraces in layers 6 to 9 inches deep. When lining out the seedlings from the seed bed, it is usual to space them about 4 inches apart. Thereafter the spacing depends very largely on the development of the individual transplants and especially of their root-systems, but does not finally exceed 8 inches under normal circumstances. The transplants are kept screened for the first year, the same type of screen being used as for seed beds. The transplants are always kept mulched with forest litter, as this improves their health and rate of growth. No mineral fertiliser has

been found to produce any significant result. On these southerly and south-easterly aspects the steep sides of the terraces are soon covered and held by liverworts and ferns, and only a temporary revetment is thus required. It is usually necessary to water the transplant beds only until the first rains after planting out, but occasionally long periods of drought in the summer months have killed off numbers of transplants at Deepwalls, when watering could not be resorted to. If a nursery is laid out in a forest, it is important to cut off the roots which enter the site from the surrounding trees. Unless a deep trench is dug round the nursery, it is sometimes necessary to cut back these roots twice a year, as they frequently retard the growth of transplants appreciably.

(c) *Field Nurseries.* In the selection of sites for field nurseries the chief factors are the finding of a sufficient depth of loamy soil over the underlying clay or rock and of an opening of sufficient size in the forest. It will usually be discovered, however, that, where the soil is suitable, there is already a stocking of poles and saplings, so that some sacrifice has to be made. The construction of a field nursery is similar to that of transplant beds. The provision of a wire-netting fence to exclude buck and trespassing cattle should not be overlooked.

General. The period of active growth of indigenous transplants is not limited by a cold winter in the Midland forest area, but by summer heat and drought. The growing season extends from about March to about November. Good rains cannot usually be relied upon until July or even August, however, and it has therefore been the practice at Deepwalls to carry out planting operations in the forest in June or July, depending on the season. This has determined the period during which the lining out of seedlings and other nursery operations have been carried out, because they have had to wait until the beds occupied by transplants, suitable for planting out into the forest, have been emptied. In favourable years, however, it would probably be more satisfactory to commence the nursery operations about March or April.

It should be noted that many of the following photographs have been primarily chosen with a view to illustrating general points, rather than particular points in reference to any given species. The effect of frequent transplanting is, for instance, illustrated only in the case of one or two species, but such illustrations are also representative of the same operation in other species.

The Treatment of Individual Species.

Real Yellowwood (*Podocarpus latifolius* R. Br. ex Mirb)

Good seed-years may be expected every 2 to 4 years, though some seed may be found almost every year. The seed is frequently parasitised by insects and the best method of collection is from low-branched trees growing on the edge of openings in the forest. A plump aril is usually a sign of a healthy seed.

The season of sowing seed may affect germination. It appears that its viability is not impaired by storage for two months, but it falls off rapidly when stored for longer periods.

The most satisfactory method of sowing is in drills covered with sand. If seed-bed space is not available when the seed is collected, the seed may be mixed with sand in an earthenware pot sunk into the soil and kept moist by frequent watering. In this case the seed and the sand are sown broadcast or in drills, either when germination commences in the pot, or when seed-bed space becomes available.

The germination of seed, sown fresh, or stored not longer than a month, has varied at Deepwalls from about 20 per cent. to 50 per cent., and is probably largely dependent on the care with which the selection of the seed was made. The following table gives the results of the sowing of three parcels of seed collected during the good seed-year of 1935. All the sowings were in drills covered with sand.

Treatment of Seed	Delay to 1st Germination (days)	Germination Period ('days')	Germination		Transplants obtained	
			% Germination	No. per lb.	% of Germination	No. per lb.
(a) Dried on gauze tray for 30 days.	67	147	43.2	613.4	77.2	473.4
(b) Same stock layered in sand 62 days.	26	126	38.2	534.6	67.1	413.6
(c) Ripe fallen seeds sown immediately.	62	152	19.7	237.0	52.7	125.0

Treatment of Transplants. On the light soils which are usually selected for nursery beds, Real Yellowwood tends to produce a rather deep root system, which is difficult to transplant, and, even in the field nurseries, the roots frequently penetrate the clayey subsoils to a depth of 12 inches or more. To obtain a bushy, superficial root system, it is necessary to replant the nursery stock frequently. This is one of the slowest-growing of the indigenous species, and a transplant is usually five years old from seed before it is ready to be put into the forest. The most suitable class of stock for planting out into the forest is probably 1 year, —1 year, —2 year, —1 year, i.e., lined out from the seed bed at one year, replanted to the field nursery at the end of the next year, and again replanted after it has been two years there. The frequent replanting retards the growth considerably, as may be seen from the following table:—

MEAN HEIGHT (Inches) AT DIFFERENT AGES FROM SEED.

1 year	2 years	3 years	4 years	5 years
1 yr. 1.3	2 yr. 4.5 1-1 yr. 2.4	1-2 yr. 7.3 1-1-1 yr. 4.5	1-2-1 yr. 11.0 1-1-2 yr. 11.0 1-1-1-1 yr. 8.3	1-1-2-1 yr. 16.8 1-1-1-1-1 yr. 14.1

This loss of growth is, however, compensated by the greater success in the establishment of transplants put out into the forest, caused by the greater ease in removing the plants from the beds and the resultant avoidance of serious injury in putting them out into the forest. See Figures 1 and 2.

COMMON YELLOWWOOD (*Podocarpus falcatus*. R. BR. *ex* MIRB)

Good seed years of this species usually occur at intervals of two to four years. Most of the seed is sound and may be collected in large quantities from the ground. Germination is frequently delayed for about nine months and then continues for a period of two years in well marked spurts, which it has not been possible to correlate with season or climatic conditions. Various chemical methods of stimulating germination have been tried without success, and layering the seed in moist sand and forest litter actually reduces the percentage germination obtained.

Treatment of Transplants. At first Common Yellowwood is slow-growing, but thereafter it may, in suitable conditions, put on 3 feet or more in height per annum. The seedlings tend to produce a rather deep root system, but it is possible to produce a very superficial root system by frequent transplanting, by bending the taproot upward, and by selecting transplant beds in heavy clay-loam soils and keeping the beds well mulched. Even under these conditions the transplants tend to send down roots deep into the underlying clay. These roots are, however, fine and very slightly branched, while a good superficial root system is produced at the same time, so that the deep roots may be cut off without serious injury to the transplant. Four year old transplants are suitable for planting out in the forest and 1-2-1 year plants are probably preferable, as frequent transplanting reduces the height growth appreciably. The 1-2-1 year transplants average 15.3 inches in height, while 1-1-1-1 year plants reach a mean height of 12.5 inches. See Figures 3 and 4.

FALCATE YELLOWWOOD (*Podocarpus Henkelii*, STAPF)

This Yellowwood is not indigenous to the Midlands, but for several years small parcels of seed have been obtained from East Griqualand for trial sowings. The seed has germinated well and the rate of growth in nurseries has been good, but in the forest the transplants have not so far fulfilled the promise they showed in the nursery and the species is not yet recommended for general trial.

The species occurs naturally in the interior of East Griqualand and Natal on the southern aspects of hills at elevations of 2,000 feet or more, where there is a relatively high rainfall, and where mists are of frequent occurrence. The soils on which the species grows are frequently clayey, derived from dolerite, and covered with ferns, such as *Polystichum pungens* and *P. adiantiforme*, or with grasses, which indicate a high moisture content of the soil. As is to be expected, therefore, the seed germinates better in moist, clayey soils than on sandy soils, which are apt to become very dry during the hot weather.

The first seed which falls from the trees is usually seriously parasitised by insects, but seed collected about May or June is usually

sound and the germination per cent. of seed sown at Deepwalls has been satisfactory. Seventy-five lbs. 12 ozs. of seed sown at Deepwalls has given 71.3 per cent. germination, yielding 108.7 seedlings per lb. Germination is usually delayed for two months or more and continues over a period of one to two months. Results in the following connection are not yet statistically established, but it is probable that soaking the fruits in cold water for 24 to 48 hours before sowing, or layering them in sand, may reduce the delay between sowing and first germination and increase the germination per cent.

One year the seedlings were attacked in the seed bed by a species of *Phoma,* which killed a number of seedlings, but in other years the seedlings have been particularly healthy.

Treatment of Transplants. Sown on shallow, moist, clayey soils, the seedlings of this species have a naturally flat, superficial root system and there does not appear to be any need for frequent transplanting. Seedlings have, however, hitherto been transplanted yearly and put out into the forest from the field nurseries at the end of the third year. The mean height for 1-1-1 year plants is 19.4 inches. See Figure 5.

Stinkwood (*Ocotea bullata,* E. Mey)

This is one of the most difficult of the indigenous species to propagate from seed. Two years or more elapse between good crops of seed on any particular tree, but scattered trees may be found in flower or fruit almost any month of the year. Many flowers are parasitised by aphids and fungi and the latter also render much of the developing fruit sterile. The viability of even carefully selected fruits is low. A comparatively high percentage of viable seed may be found in the droppings of bush doves, loeries, or starlings and 5 oz. of such seed (470 seeds) sown at Deepwalls gave 13.4 per cent. germination or approximately 202 seedlings per lb.

Seed collected beneath trees is frequently parasitised to such an extent that an infinitesimal amount germinates. Seed collected from the trees should be sown immediately as even a month's storage tends to destroy its viability.

In the forest young Stinkwood seedlings are most frequently found in the wet type in the dense shade of tree ferns (*Hemitelia capensis*). The light intensity under these ferns is often as little as 1/1,000th of full sunlight, while the soil is constantly wet and covered with undecomposed litter. To simulate these conditions a thatched hut was constructed in which Stinkwood seed was sown in tins. Mulching or maintaining an excessively wet soil in the tins did not increase germination, but in these dark conditions, with ordinary sandy nursery soil kept moist by daily watering, the most successful results were obtained. The average germination per cent. in this screen has been 25.8, but the importance and difficulty of selecting the seed is shewn by the fact that the germination per cent. in various parcels of seed has varied from 1.5 to 41.9. The experiments have also shown that ripe fruits germinate better than those which are not quite mature.



FIG. 1.—A 2 YEAR REAL YELLOWWOOD SEEDLING shewing length of taproot. Height 4 inches; root penetration 9.3 inches.

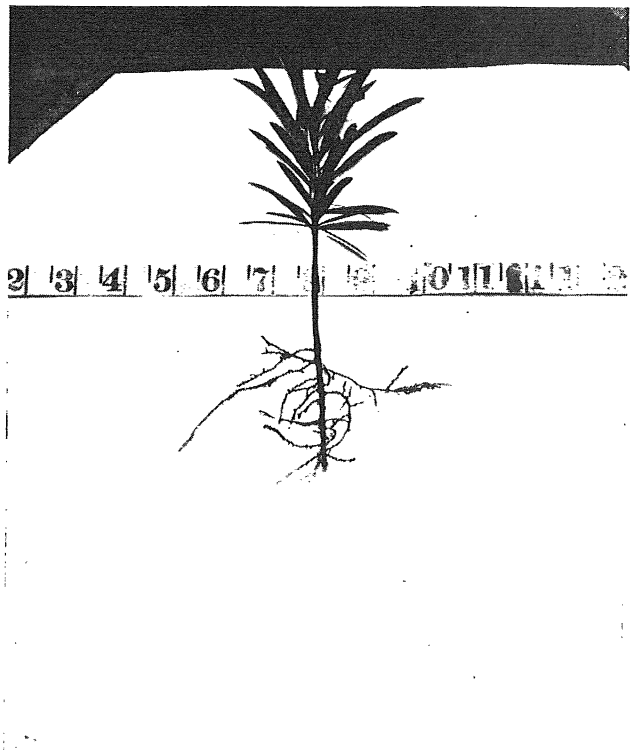


FIG. 2.—A 2 YEAR REAL YELLOWWOOD SEEDLING shewing how the taproot should be cut back for transplanting.

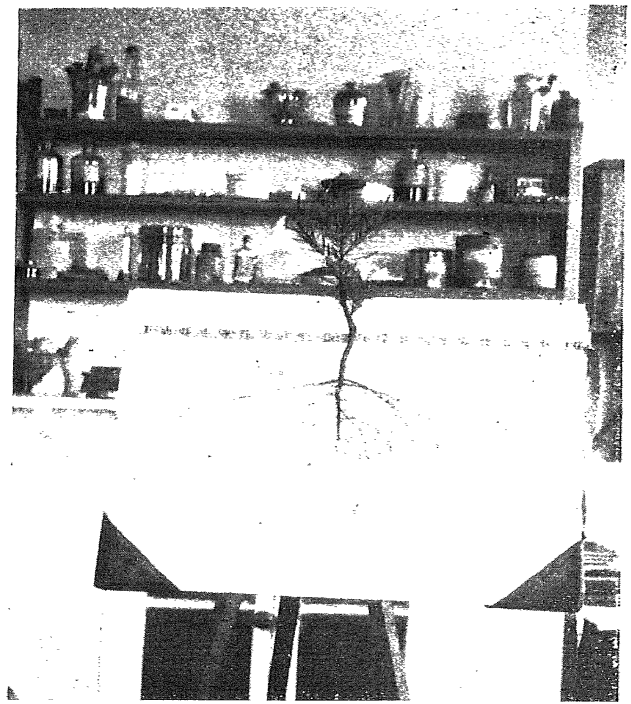


FIG. 3.—A 1 YEAR -3 YEAR TRANSPANT OF COMMON YELLOWWOOD from a rather dry, well-drained bed. The transplant has been put out about 2 inches too deep. No roots have come up into the mulch and the root system is diffuse and rather deep. Height 9 inches; root penetration 13½ inches.

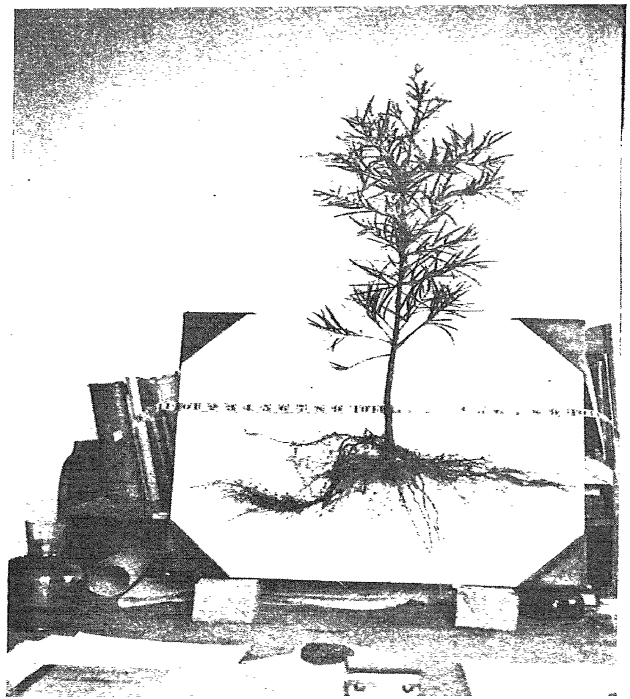


FIG. 4.—A 1-1-1-1 YEAR TRANSPLANT OF COMMON YELLOWWOOD from a heavy clay-loam soil well aerated by earth worms. Note the compact, spreading root system resulting from frequent transplanting, heavy soil, and bending the roots upwards at the time of replanting. Several roots come up into the mulch and the few roots which tend to go down into the subsoil are of no significance. Height 20 inches; root penetration 10 inches.

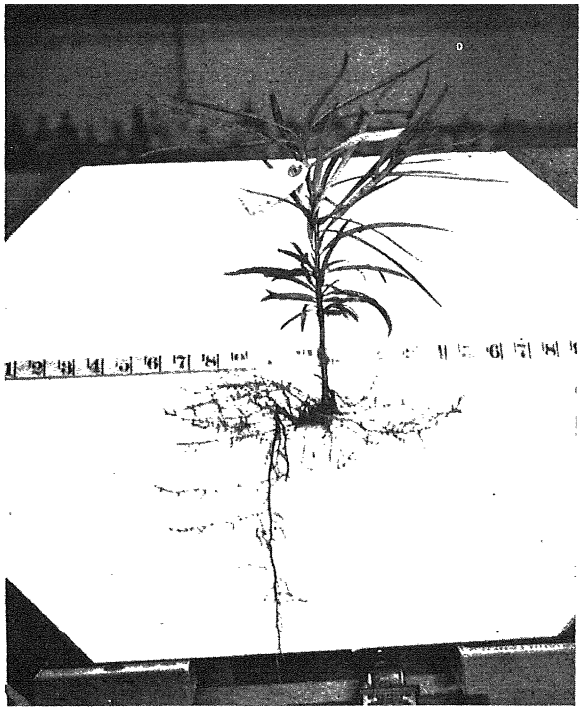


FIG. 5.—A ½-1 YEAR TRANSPLANT OF FALCATE YELLOWWOOD grown on about 6 inches of sandy loam over clay. There is a good superficial root system, but the tap root, although bent to one side when transplanted, has again descended vertically. Height 8½ inches; root penetration 11 inches.

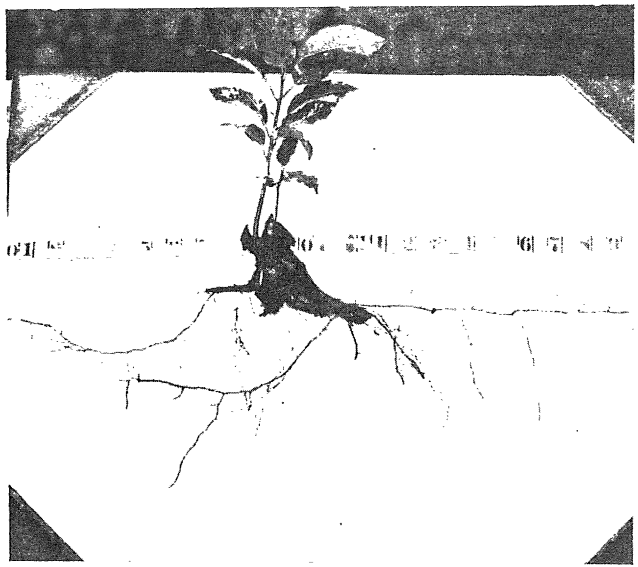


FIG. 6.—A 1 YEAR STINKWOOD STUMP from a light sandy soil, shewing the stump originally planted. Note non-fibrous root system. Height 6 inches; root penetration 8½ inches.

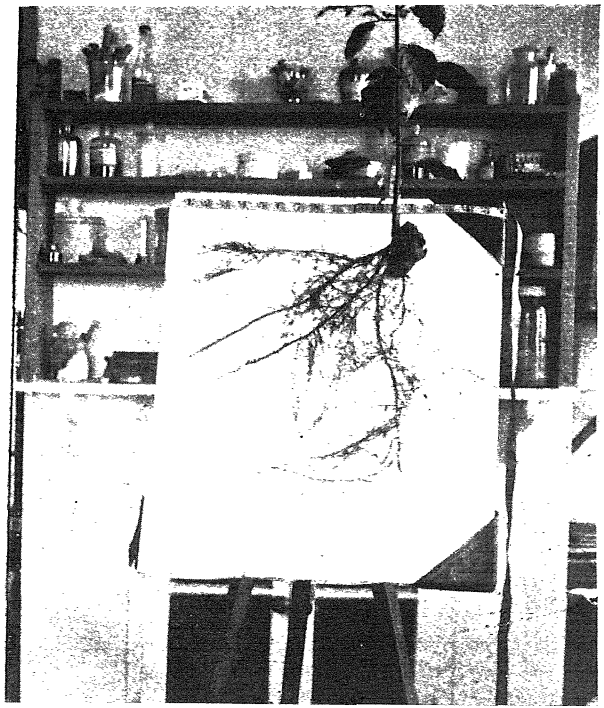


FIG. 7.—A 3 YEAR STINKWOOD STUMP from a humus loam soil with good sub-soil drainage. Height 21 inches; root penetration 12 inches.

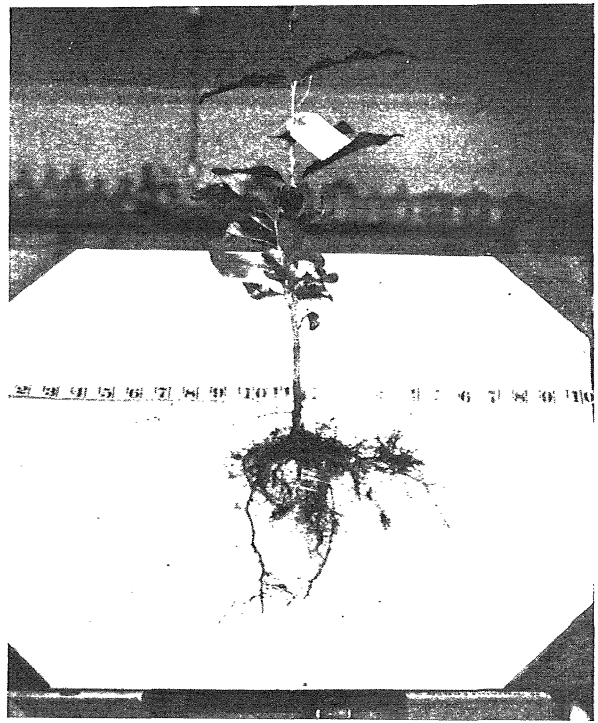


FIG. 8.—A ½-1-1 YEAR TRANSPLANT OF IRONWOOD from a well mulched but distinctly clayey soil. A dense tufted system of fibrous roots has been obtained, but some roots tend to go down into the underlying clay. Height 16½ inches; root penetration 8½ inches.



FIG. 9.—A 9 MONTHS OLD SEEDLING OF ASSEGAI from seed bed with deep, sandy soil. Height 2 inches; root penetration 7 inches.

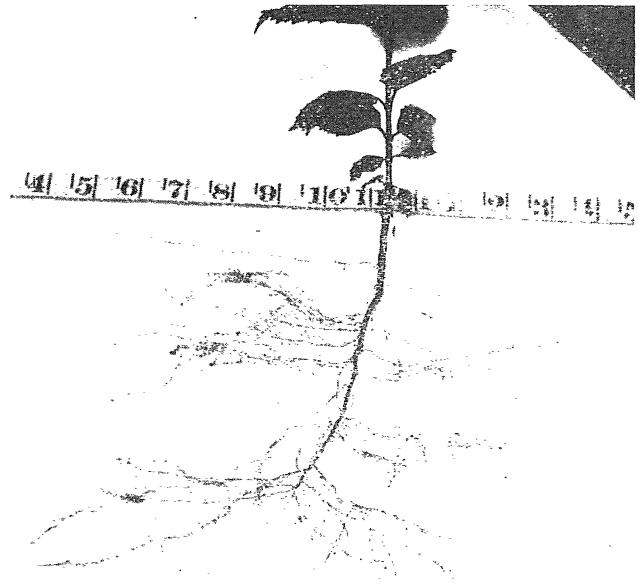


FIG. 10—A SEEDLING OF ASSEGAI from the same bed as that in Plate 9, but removed a year later. Height 4½ inches; root penetration 10 inches. Either of these seedlings is quite suitable for replanting, if the taproot is cut about 6 inches below the surface.

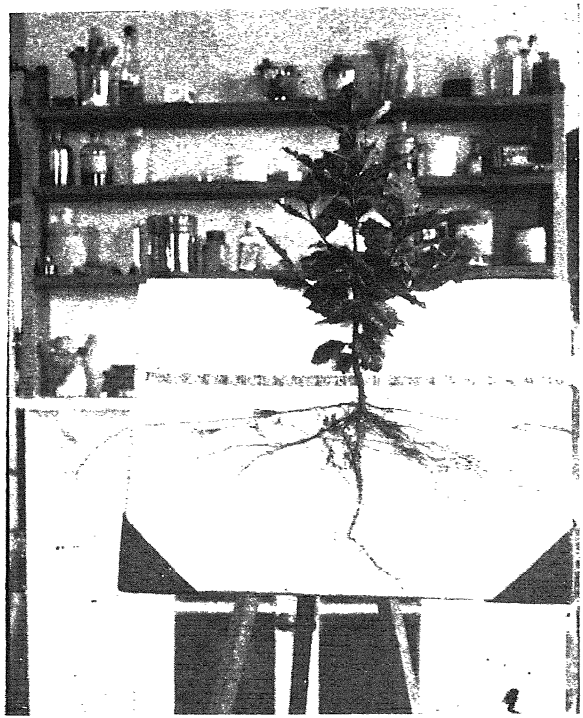


FIG. 11.—A 1-2 YEAR TRANSPLANT OF ASSEGAI from a well-drained bed shewing the great development of the deeper roots. Height 7 inches; root penetration 13 inches.

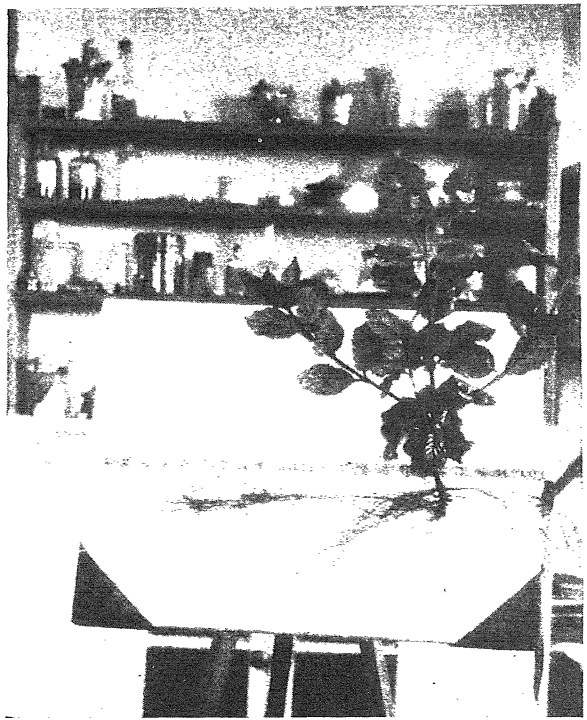


FIG. 12.—A 1-2 YEAR TRANSPLANT OF ASSEGAI from a bed with about 4 inches of sandy loam over clay loam, rather poorly drained, shewing superficial root system in comparison with Plate 11. Height 16 inches; root penetration 6 inches.

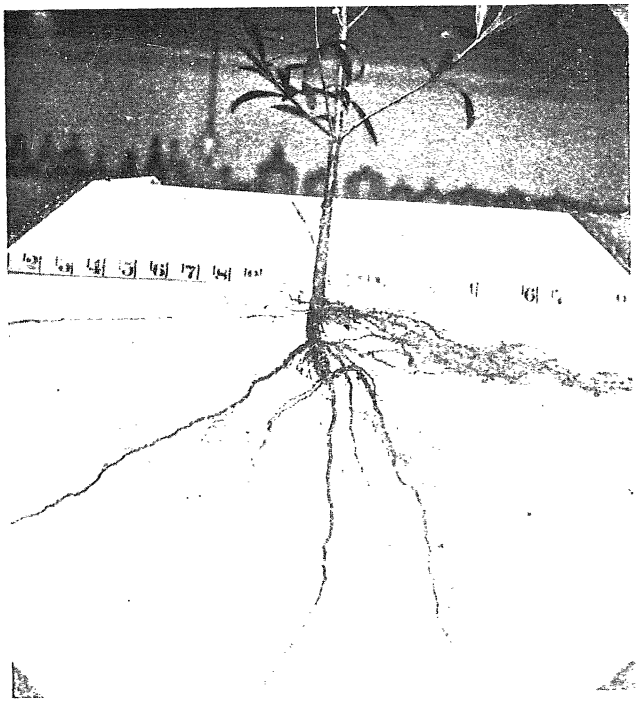


FIG. 13.—A 1-1-1-2 YEAR TRANSPLANT OF KAMASSI from a bed overlying a clay-loam illustrating the danger of deep development, even on such soils, if transplanting is not undertaken with sufficient frequency.

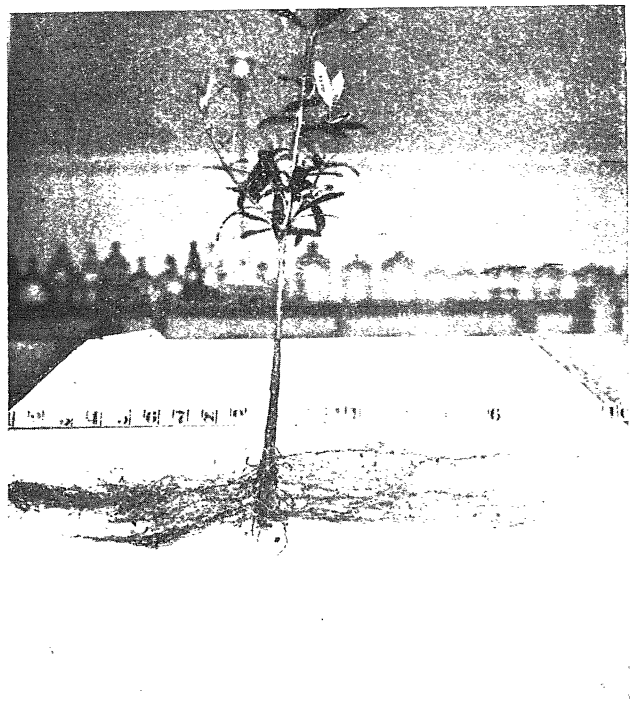


FIG. 14.—A 1-1-1-1-1 YEAR TRANSPLANT OF KAMASSI from the same stock as Plate 13 shewing that frequent transplanting is effective in keeping the root system entirely superficial.

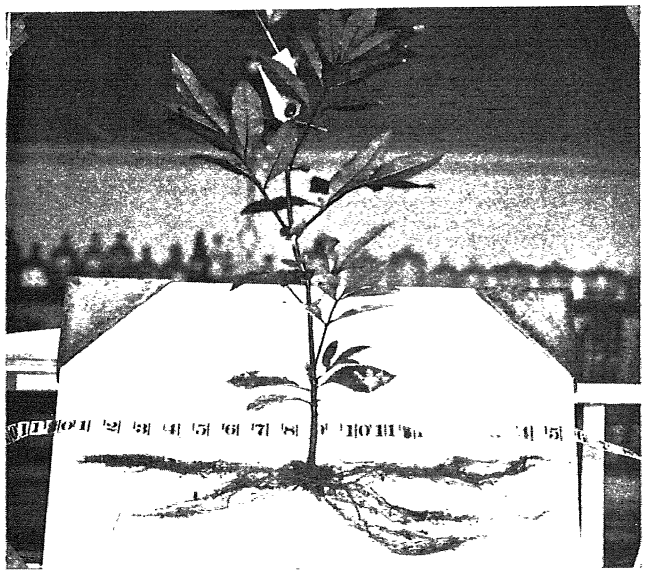


FIG. 15.—A 1-1-1 YEAR TRANSPLANT OF ROOIELS showing vigorous growth and very superficial root system on a moist, shallow loam over clay. Height 16 inches.



FIG. 16.—A 1 YEAR -3 YEAR TRANSPLANT OF ROOIELS from a well-drained soil. The leaves are somewhat scorched and growth has been slower than in Fig. 15, but the root system remains superficial and the plant is considerably hardier. Height 15 inches.

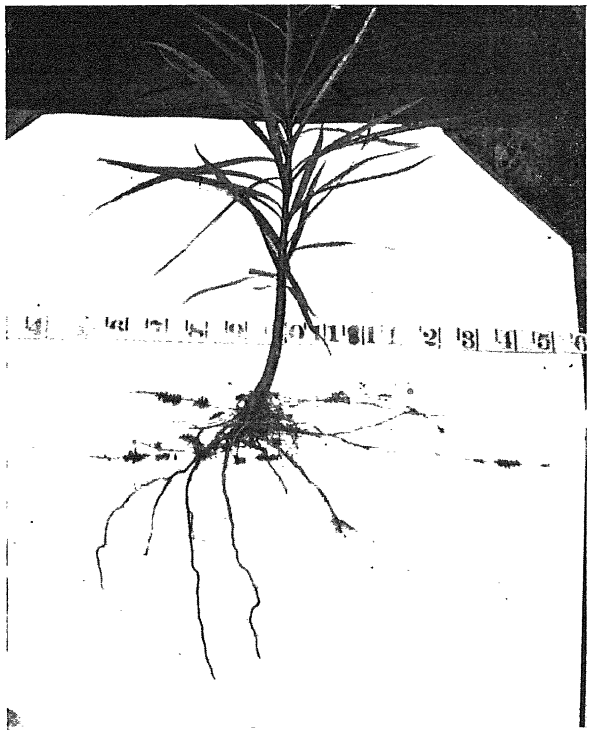


FIG. 17.—A 1-1-1 YEAR TRANSPLANT OF TERBLANS grown on 4 inches of sandy loam over clay loam and shewing "bottle brushes." Deep roots have been developed in spite of the heavy underlying soil and annual transplanting. Height 24 inches; root penetration 10 inches.

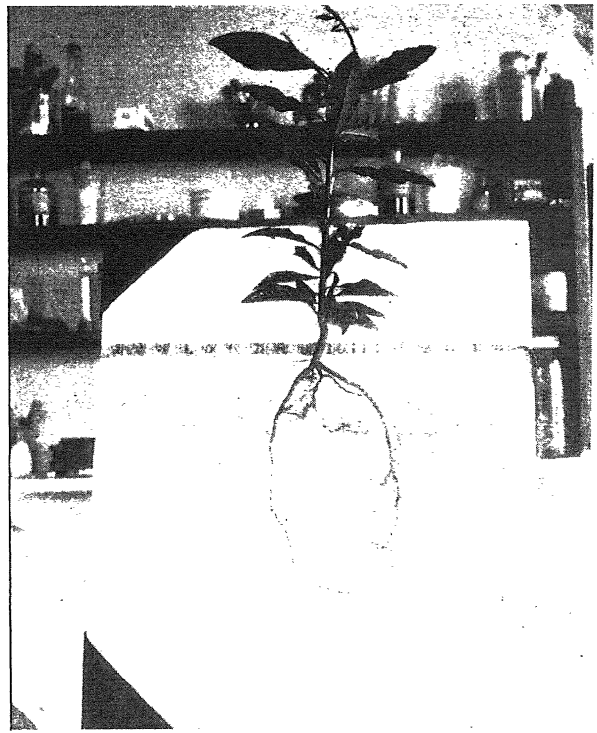


FIG. 18.—A 1-2 YEAR TRANSPLANT OR BEUKENHOUT from a shallow loamy soil over a stiff clay loam. In spite of the mulching of the surface and the heayiness of the sub-soil, the plant has produced a deep root system with few fibrous roots.



FIG. 19.—A 1-1-1 YEAR TRANSPLANT OF BEUKENHOUT from the same stock as Plate 18 and grown on a similar soil. Replanting has produced a bushy, superficial root system.



FIG. 20.—A 1-1-1 YEAR TRANSPLANT OF ESSENHOUT shewing the development of a mass of fine, fibrous surface roots after transplanting to a bed with about 6 inches of sandy soil over a stiff clay-loam.

Attempts to raise this species from slips and truncheons have been unsuccessful, but "stumps" have given good results. Throughout the medium-moist type of forest considerable numbers of young Stinkwood may be found. These plants are usually completely suppressed and are, moreover, often attacked by the Stinkwood borer. This Cerambycid grub usually enters the stem a few inches above the ground and bores up the pith. As a result the attacked stem usually dies back to the point at which the grub entered, and many plants 4 to 10 feet high show signs of two or three stems, which were previously killed off in this way. Such plants have very little chance of developing and it is justifiable to replant them where they have a better chance of succeeding.

Large numbers of such plants have been transferred to the Deepwalls nurseries. The stems are cut back to ground level, the roots drastically pruned, and the "stumps" lined out in beds. Unless they are planted out in sandy or loamy soils, the growth and root development are poor. Sixty per cent. or more of these "stumps" have frequently been successfully established.

The transplanting of nursery stocks so raised is, however, very difficult. Stinkwood does not produce a fibrous root system under any conditions and the young roots which are usually about 1/12th inch in diameter, with a very wide cortex, are easily damaged in the process of digging out, bundling, and replanting. The injured roots die off entirely, the stems in consequence dying back and, though the stumps may shoot again, the previous growth is lost. The only practical method of propagation thus appears to be to grow the "stumps" where they are ultimately required, and to keep them well weeded until they are able to compete with the weed growth. The selection of suitable sites for putting out these "stumps" will then be a matter of the greatest importance. A three year old "stump" average 18.3 inches in height. See Figures 6 and 7.

Ironwood (*Olea laurifolia*, Lam.)

Ironwood has not been raised on any scale in the Deepwalls nurseries on account of its natural abundance in the forest, its rather slow growth, and its liability to be eaten off by buck and cattle.

Very large quantities of seed are borne every two to four years. The seed is usually fertile and as many as 3,000 seedlings per square metre have been counted under seed trees, though these seldom persist more than a few months. Seed viability appears to be reduced by storage for periods of over nine months and continuous moistness of the soil is probably an important factor in stimulating germination. Mulching the bed thoroughly after sowing thus increased the germination from 50 per cent. to 69.6 per cent., while layering of the seed for one to four months in sand, which was kept constantly moist, increased germination from 62.3 per cent. to 74 per cent.

The delay between sowing and first germination has varied from 67 to 173 days, while the period over which germination proceeds sometimes exceeds a year. The seed beds must be screened in order to reduce evaporation and prevent insolation. See Figure 8.

ASSEGAI (*Curtisia faginea*, AIT.)

This species usually bears fairly light crops of seed annually. Generally only one, occasionally two, of the four seeds in the fruit germinates. The inflorescences are frequently galled, but the fruits, once developed, are not usually parasitised and may be collected from the ground or from low-branching trees.

Germination is usually much delayed and proceeds for a year or more. No method of reducing this period has been found, but seed bed space may be saved by layering the seed in pots of sand or forest litter, kept continuously moist, for periods of four to eight months. The greater moisture retaining capacity of forest litter appears to render it more suitable for layering than sand. Storing the seed in gauze trays for periods of more than a month reduces the germination capacity of the seed and it is generally preferable to sow it immediately after collection. About 1,086 freshly collected fruits and 3,350 dried fruits go to the pound.

Treatment of Transplants. Assegai, even on poorly drained clay-loam soils, has a tendency to form a deep root system. It is thus customary to transplant each year. At the age of four years it is ready to plant out. The 1-1-1-1 year plants average 15.7 inches in height. See Figures 9, 10, 11 and 12.

KAMASSI (*Gonioma kamassi*, E. MAY)

Kamassi flowers and fruits sparingly every year. The germination of seed is so poor that all the stocks raised in the Deepwalls nurseries have been young seedlings removed from the forest. These seedlings are nowhere abundant, but difficulty in obtaining 3,000 or 4,000 seedlings per annum for the nurseries has seldom been experienced.

This species, although found throughout the forests, attains its largest size in the moist type of forest, whereas in the medium moist and dry types it is smaller and frequently unsound. Similarly, in the nurseries this species has been found to be healthier and faster growing on poorly drained beds with a few inches of loamy soil over clay or clay loam. On such soils the root system is usually superficial, though a very deep root system may be produced if frequent transplanting is not resorted to. Such plants have grown very rapidly in the nurseries, but, apart from the inevitable damage to the root-system during replanting, the young growth is so soft and sappy that they wilt very badly. It has been customary at Deepwalls, therefore, to transplant frequently. The ease with which superficially rooted plants can be transplanted prevents any very marked reduction in the rate of growth on this account. Five year old transplants (1-1-1-1-1 year) have a mean height of 16.4 inches. See Figures 13 and 14.

ROOIELS (*Cunonia capensis*, L.)

This species is characteristic of forests of the wet types at higher elevations, where natural regeneration is markedly deficient on account of the density of the weed-growth, and where much of the artificial regeneration of the forest is consequently being attempted.

The species flowers and fruits abundantly every year and is very easy to raise from seed, though for some time very poor results

were obtained owing to the fact that the seed was covered with soil in the seed beds. Even though the germination per cent. is low, it is difficult to sow the seed so as to avoid the dense overcrowding of the seedlings, as there are approximately 1,200,000 seeds to the pound. The best plan is probably not to attempt to clean the seed, but to sow the capsules, which should be collected from the trees when they are strongly tinted red, i.e., just before they ripen, open, and drop their seed. The seed bed should have a somewhat clayey soil and be kept screened, so that the soil may remain moist when watered twice daily. It is difficult to sow broadcast at a lighter rate than 1 lb. per 200 square feet, but the resulting dense germination can easily be thinned out. Such a sowing should yield at least 8,000 utilisable seedlings to the pound.

Treatment of Transplants. To raise transplants for planting out, it is most satisfactory to use beds with rather clayey sub-soils throughout, but plants on such beds are liable to become very tender, and if transplants are required for use in the forest, it is best to harden them on better drained soils. On such well drained beds at least 50 per cent. deaths may be anticipated in the two years during which they should remain in the transplant beds. The root system is very superficial and frequent transplanting is thus unnecessary. Four year old transplants (1-1-1-1 year) attain a mean height of 45.9 inches. See Figures 15 and 16.

TERBLANS (*Faurea Macnaughtonii*, PHIL.)

Terblans has been used to some extent in the artificial regeneration of portions of Deepwalls Forest, because it is easy to raise in the nursery and grows comparatively rapidly. The trees at Gouna are tall and clear boled, so that it has not been possible to collect seed, but the species seeds yearly and young seedlings are readily obtained.

The species tends to produce a deep root system with comparatively few fine roots. The roots mainly arise in "bottle brushes" along ½ inch or 1 inch of the length of a larger root, just behind the growing tip. These "bottle brushes," which are white when young, contain the mycorrhizal fungus, but turn brown within a few months and are probably no longer functional. The fine roots of the "bottle brush" are in any case dead when about a year old.

It has not been possible, either by frequent transplanting or by planting on heavy soils, to prevent the formation of deep-going roots entirely, but by these means a mainly superficial root system may be produced, yielding plants quite suitable for planting out in the forest. Four year old transplants (1-1-1-1 year) reach an average height of 28.2 inches.See Figures 17.

BEUKENHOUT (*Rapanea melanophleos* (L.) MEZ.)

Beukenhout is, in the Midlands, more frequent in the coastal forests on sandy soils, and in forests growing on soils derived from Malmesbury shales, than in the main forests. The species has, however, been used at Deepwalls to some extent, chiefly because of its comparatively rapid growth and the ease with which it is raised from seed.

Heavy crops of seed are borne almost every year. Storage of the seed in gauze trays for periods of up to four months has not been found to affect its germinative capacity. The weight of seed so stored is approximately 4,800 to the pound. A germination of about 50 per cent. can usually be expected. Germination is delayed for six months and continues over a period of four months. Seed bed space may be saved by layering the seed in sand for three months.

Treatment of Transplants. Beukenhout shows a very marked tendency to produce a deep root system, even on clayey soils, unless it is frequently transplanted; but, with annual transplanting and the bending up of the roots, it is possible to produce a satisfactory, superficial root system on heavy soils.

One-1-1-1 year transplants are usually used for planting out into the forest, where the species has grown well even on very wet soils and has shewn a striking capacity for competing against and growing through dense weed growth. Such transplants (i.e., 1-1-1-1 year) average 17.7 inches in height. See Figures 18 and 19.

ESSENHOUT (*Ekebergia capensis*, SPARM.)

Essenhout is very occasionally found within the Midland forests, but is more frequent in the coastal bush on deep, sandy soils or near the banks of rivers. On account of the frequent (almost annual) good crops of seed, and the ease of raising it in the nursery, it has been tried to some extent at Deepwalls, but in the wet areas which are usually planted up it is unhealthy and unsatisfactory. A certain amount of information has however been collected about this species and a few notes on it are therefore included.

The fruits are often parasitised by insects when they are nearly ripe, and it is always advisable to remove the seed from the fleshy fruits as soon as possible. Storing the seed for periods of up to four months has not impaired its viability. Germination in sandy soils on a northern aspect has been much greater than in loamy soils or clayey soils, and the screening of beds has greatly improved the germination per cent. and greatly reduced the number of deaths in the seed bed. About 4,000 cleaned seeds or 60 fruits weigh 1 lb. Germination usually commences two months after sowing. Many germinations take place during the following three weeks, but occasional germinations may occur for another two months.

Treatment of Transplants. To obtain the desired bushy root systems, it is necessary to line out the seedlings in beds with a distinctly clayey sub-soil, and to transplant each year. During the first year in the transplant beds growth is slow, the plants are yellow and sickly in appearance, and up to 30 per cent. deaths may be expected. Thereafter growth is healthier and more rapid. Three year transplants are suitable for planting out, and average 15.3 inches in height. See Figure 20.

SUMMARY.

A technique which has proved successful for raising transplants of indigenous species for open-rooted planting at Deepwalls is outlined. The following species are dealt with: *Podocarpus latifoluis, P.*

falcatus, P. Henkelii, Ocotea bullata, Olea laurifolia, Curtisia faginea, Gonioma kamassi, Cunonia capensis, Faurea Macnaughtonii, Rapanea melanophleos and Ekebergia capensis. Brief notes on the time of seeding, the collection and treatment of seed, and the choice and preparation of nursery beds are also included.

The importance of producing superficially rooted plants, in order to facilitate transplanting, is stressed and the use of shallow beds over clayey subsoils, repeated transplanting, and bending up of the roots at the time of transplanting are suggested as effective measures for attaining this object.

L.S.G.

Reprinted from the
Journal of the South African Forestry Association
No. 1, October, 1938

THE RATE OF GROWTH AND HEALTH OF THE SOUTHERN PINES IN THE MIDLAND CONSERVANCY.

By S. P. SHERRY

(*Forest Research Officer, Tokai, C.P.*)

General.

THE area included in this study is that portion of the Midland Conservancy between George and Clarkson and running from the foothills and lower slopes of the Outeniqua Mountains to the sea. The whole of this area falls within the zone of constant (all the year round) rainfall.

The first introduction of the Southern pines into the Midlands took place in 1910-11 when stands of *P. palustris* were established at Concordia Plantation near Knysna. In 1913 the first stand of *P. taeda* was established at Witfontein Plantation near George, and four years later stands of the same species were planted at Witelsbos and Blouleliesbos Plantations in the Storms River District. The stand at the latter centre to-day carries the best crop of *P. taeda* in the Conservancy with a volume of well over 4,000 cubic feet per acre at 20 years of age. It is largely due to the rapid and healthy growth of the above mentioned stands that *P. taeda* has been planted so extensively in the Midlands in recent years. *P. caribaea* was the next species to be introduced and a stand was established at Concordia in 1918.

After the introductions mentioned above there was a lull in the planting of the Southern pines due, in part, to the scarcity of seed supplies from America occasioned by poor seed years from 1918 to 1923. From 1923 to 1927 a few stands of each of the above three species were established at various centres, but it was not until 1929 when further afforestation with *P. insignis* was restricted to the most favourable sites on account of the ill health of many established stands of that species, that further afforestation with *P. taeda* and *P. caribaea* was begun. *P. palustris* has never been planted extensively in this Conservancy and *P. echinata,* the remaining important Southern pine species, has been introduced so recently into the Midlands that the few stands which have been established are too young to warrant their being included in the present study.

It must be realised therefore that the majority of stands from which data were derived are less than ten years old and may not have expressed themselves in respect of their reaction in health and rate of growth to site conditions. For this reason an attempt has been made in drawing conclusions from the data to give emphasis

only to those points which experience has shown to have probable significance.

Collection of Data.

The study described herein was begun in an attempt to discover the causes of ill health which was becoming increasingly apparent in stands both of *P. taeda* and *P. caribaea*, but particularly the former species, in plantations in this area. It was decided to collect data by means of which the growth rates of the three Southern pine species could be compared and, at the same time, to collect as much information as possible on the health of the species in relation to site and soil.

The following procedure was adopted in the collection of data :—

(1) After a preliminary reconnaissance stands of each species, representative of all age classes on as many different sites as possible, were selected and a temporary sample plot 0.1 acre in area laid out in each.

(2) The diameters at breast height of all the trees in each plot were then measured and heights of from 15 to 25 trees representative of the diameter range were also taken.

(3) A soil pit was dug close beside a tree in each plot so as to expose the vertical root system and part of the laterals. The profile so exposed was described, measurements of the depth of the root system were made and a photograph taken of the profile and the exposed portion of the root system.

(4) Detailed observations of the form and branching of trees in stands raised from seed stocks of different origin were made with a view to determining the effect of seed provenence on form.

(5) Detailed notes on the health of all stands were made, the presence or absence of the following main symptoms of ill health being noted.

(a) Chlorosis or yellowing of the needles. This is the most common symptom of ill health, particularly in the case of *P. taeda*, and consists in a gradual change in the colour of the needles from the normal pale yellowish green of *P. taeda* or dark green of *P. caribaea* to a bright canary yellow. Needles begin to change colour at their distal ends and chlorosis appears first at the tips of the branches. As the condition develops large masses of needles become chlorotic and are shed and ultimately the tree may become almost completely defoliated.

(b) The symptom which, for want of a better name, is here referred to as "needle wilt." This condition usually involves the needles at the ends of side branches only and causes the affected needles to droop and become twisted about their long axes. The wilted needles die and become greyish in colour but are not shed immediately. They are occasionally colonised by the fungus *Sphaeropsis pinicola* Speg. but this organism is not always present.

(c) The presence of "dwarf needles." This condition appears to follow severe chlorosis with its accompanying defoliation and consists in the production of needles very much shorter than the

normal for the species. These needles are sometimes borne in clusters on short spur branches and form a very scanty crown. Dwarf needle occurs in both *P. taeda* and *P. caribaea* but has not been observed in *P. palustris*.

(d) Dead leading shoots or branch tips killed by the entry of *Sphaeropsis pinicola* into the tissues. This form of attack is more common in stands of *P. caribaea* but is found also in *P. taeda* and occasionally in *P. palustris* stands.

Application of Data.

The first step in the application of the collected data consisted in the computation of the volume and stocking per acre of each stand from the sample plot measurements. Trees were grouped by inch classes, heights read from d.b.h./height curves drawn for each plot and volumes calculated by the use of an arbitrary form factor of 0.4 for all stands up to 7 years of age and 0.35 for all stands over this age.

Owing to different thinning regimes having been employed in many stands of the same age, it was found necessary to bring all plots in the same age class to a common stocking in order to make all the data comparable. This was done according to an arbitrary schedule based on the stocking of the majority of stands in each age class. In the case of plots with a denser stocking for their age than that appearing on the schedule, as many of the smaller sized stems were deducted as was necessary to reduce the stocking to conform with the schedule. Similarly the stocking of less densely stocked plots was increased by the addition of the required number of smaller sized stems. The dimensions of such stems as were added in this way were obtained from the tally of a less heavily thinned plot of the same age on a similar site. The volume per acre was adjusted according to the number and dimensions of the stems added or subtracted.

Since it was obvious from an examination of the numerical data that site conditions had influenced both growth rate and health, the data were grouped according to site. The number of plots on many of the soil types was unfortunately insufficient to make it possible to draw conclusions regarding the effect of soil type on growth. With regard to the influence of soil type on health, however, it was found that soil type *per se* has little effect on the health of *P. taeda*. This species is healthy on fertile Bokkeveld loams on cool aspects but does not thrive on the less fertile soils unless these possess a high humus content. Provided sufficient humus is present the most suitable soils for this species are deep moist sandy loams or sandy clays on cool aspects. *P. caribaea* will thrive on most moist soils and can be planted successfully on sandy loams, loams or sandy clays on level ground where drainage is poor, or on heavy clays on slopes where there is fairly good drainage. As far as can be deduced from the small number of stands examined, *P. palustris* is most healthy on deep well-drained sands or sandy loams.

In general it may be said that, on account of the relative infertility of the soils in this region, the majority of which are derived from

the Table Mountain Sandstone series, the presence of a good humus layer plays a major part in inducing healthy growth.

On account of the difficulty of correlating rate of growth with soil type it was decided to classify soils according only to their humus content. Sites were grouped according to slope and aspect from the point of view of moisture content and drainage. The following are the soil and site classifications employed.

(1) Old Forest Soils. Soils rich in humus derived from pre-existing indigenous high forest.

(2) Fynbos Soils. Soils with a fair humus content derived from mature or semi-mature fynbos or macchia.

(3) Veld soils. Soils lacking in humus or with a low humus content as a result of repeated burning of the veld for grazing in the past. Sites were divided into four classes as follows:—

(A) Dry hot sites. Sites on steep slopes with northern or western aspects.

(B) Well drained sites. Sites on gentle slopes with northern to western aspects and sites on steep slopes with southern to eastern aspects.

(C) Moist cool sites. Sites on gentle southern to eastern slopes and sites on level coastal plateaux.

(D) Wet sites. Sites on vlei soils in hollows or along the sides of streams.

Influence of Soil Moisture on Health.

When all stands are grouped in the above site classes and those which are absolutely healthy are segregated from those which show symptoms of ill health of one kind or another the effect of site on health can be readily seen. The data in Table I are expressed as percentages of the total number of stands of each species included in this study.

TABLE I.

Species	Dry		Well Drained		Moist		Wet		Totals	
	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy
	%	%	%	%	%	%	%	%	%	%
P. taeda ...	2.8	18.8	11.3	24.5	13.2	25.5	0	3.9	27.3	72.7
P. caribaea...	3.4	6.7	14.6	24.7	20.2	19.1	3.4	7.9	41.6	58.4
P. palustris...	6.2	12.5	18.7	37.6	6.2	18.8	—	—	31.1	68.9

The effect of soil moisture as determined by site on the health of each species is more clearly evident when their data are expressed as percentages of the number of stands per soil type (Table II.)

TABLE II.

Species	Dry		Well Drained		Moist		Wet	
	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy
	%	%	%	%	%	%	%	%
P. taeda ...	13.0	87.0	31.6	68.4	34.1	65.9	—	100
P. caribaea ...	33.3	66.7	37.1	62.9	51.4	48.6	30	70
P. palustris ...	33.3	66.7	33.3	66.7	25.0	75.0	—	—

From the above table it is evident that while both *P. teada* and *P. caribaea* are most healthy on the moist sites and *P. palustris* on the drier and better drained sites, *P. caribaea* is tolerant on a wider variety of sites than is *P. taeda*. There are unfortunately too few plots of *P. palustris* for a fair comparison to be made between this species and the other two, but the indications from field observations are that *P. palustris* is also tolerant over a fair range of site types.

Table III gives the incidence of the four main disease symptoms discussed above expressed as percentages of the number of stands per soil type for each species. Some stands exhibit more than one of these symptoms and are consequently included more than once..

TABLE III.

Site Type	Chlorosis			Needle Wilt			Dwarf Needle			S. Pinicola		
	Ptae	Pcar	Ppal	Ptae	Pcar	Ppal	Ptae	Pcar	Ppal	Ptae	Pcar	Ppal
Dry	70	44	33	22	11	—	35	44	—	4	44	—
Well Drained ...	60	42	55	18	6	11	29	31	—	8	23	11
Moist	46	28	25	10	9	—	20	14	—	5	3	—
Wet	75	30	—	—	—	—	25	10	—	—	40	—

From this table it will be noticed that chlorosis accounts for by far the greatest number of unhealthy stands while *S. pinicola* is apparently an important factor only in the case of *P. caribaea* and then only on wet or very dry sites. The high percentage incidence of this fungus on the wet sites can be accounted for in part by the fact that vlei sites surrounded by stands of unhealthy *P. insignis* have in most cases been planted up with P. caribaea. These young stands have consequently become infected by spores of the fungus carried in wind-driven rain from *P. insignis* trees on the higher ground.

It will be noted that in the case of *P. taeda* the lowest percentage incidence of all the symptoms of ill-health, except attack by *S. pinicola,* occurs on the moist sites. *P. caribaea* is least affected by chlorosis and *S. pinicola* on the moist sites, but shows least needle wilt on well drained sites and greatest freedom from dwarf needle on wet sites. *P. palustris* is affected to a marked degree only by chlorosis and no case of dwarf needle was recorded for this species.

The Influence of Soil Fertility (Humus Content) on Health.

The influence of humus content of the soil on the health of Southern pines is shown in Table IV. The data are expressed as percentages of the number of stands per soil type for each species.

TABLE IV.

Species	Old Forest Soils		Fynbos Soils		Veld Soils	
	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy
P. taeda ...	57	43	17	83	17	83
P. caribaea ...	59	41	33	67	33	67
P. palustris ...	50	50	43	57	25	75

It is interesting to note that the health of *P. taeda* and *P. caribaea* is no better on the fynbos soils than it is on soils poor in humus. *P. palustris,* however, shows a rapid decrease in health with decreasing humus content.

Root Systems.

The study of root systems failed to throw any light on the problem of the causes of ill health in the Southern pines. In no case were diseased roots found and on the wettest sites no dead or decomposed roots were observed even where the level of the water table showed signs of marked fluctuation. The deepest-going roots of *P. caribaea* are apparently able to survive fairly lengthy periods of submersion as a result of a rise in the level of the water table and healthy roots of this species were found as much as 18 inches below the level of free water in the soil.

The vertical roots of *P. taeda* seem usually to avoid entering the zone of water table fluctuation by turning laterally, but in the lighter soils, where drainage and aeration are good, roots penetrate to considerable depths and occasionally suffer immersion for short periods without apparent ill effects.

Typical root systems of the three species are illustrated in Figures 1 to 3. In *P. taeda* (Fig. 1) the surface lateral root system is very strongly developed and numerous lateral roots are given off at depths of from 2 inches to 9 inches from the surface in the zone of greatest humus content. These laterals ramify freely in the surface layers of the soil and a dense mat of fine roots, many of which are mycorrhizal, is produced. There is usually at least one stout tapering tap-root penetrating to a depth of 3 feet or 4 feet from near the apex of which one or more slender vertical roots are frequently produced. These may penetrate to depths of 6 or 7 feet in light soils but are often diverted laterally by heavy clay substrata. In addition there are invariably numerous slender vertical roots given off from the lateral roots and these may also penetrate to considerable depths.

P. caribaea (Fig. 2) has usually a less strongly developed surface root system than that of *P. taeda* but several fairly strong lateral roots are usually given out and these ramify in the surface soil. Some of the lateral roots, however, turn and strike downwards at varying distances from the main stem while many give off strong sinker roots which penetrate to considerable depths. One or more strong tap-roots are developed and these penetrate to depths of from 4 to 12 feet, entering even heavy clay substrata without apparent difficulty. Numerous slender lateral roots are given off from the tap-roots for the first 3 to 4 feet of their length and these usually strike downwards in a diagonal direction a few inches from the parent root.

In *P. palustris* (Fig. 3) the tap-root is typically very strongly developed and the lateral root system less well developed even than that of *P. caribaea.* A few large lateral roots ramify in the surface layers giving off fairly numerous fine roots, some of which are mycorrhizal, but rarely producing vertical sinker roots. There is usually a single tap-root which may be as much as 6 inches in diameter at its origin and tapers only slightly for the first few feet.

This strikes vertically downwards and may reach depths of over 9 feet in light soils. A few short slender rootlets are given off along its length and the tip often ramifies into a brush-like mass of rootlets.

On dry shallow soils which are unfavourable to healthy growth of both *P. taeda* and *P. caribaea* the root systems of these species become considerably altered (Figs. 4 and 5). In both species the main roots are usually poorly developed but masses of slender rootlets are produced from both lateral and vertical roots and particularly from the former. In *P. palustris* a similar type of root system is produced on dry stony soils which prevent the formation of the typical tap-root and result in the production of numerous laterals with masses of fine rootlets (Fig. 6).

Rates of Growth of *P. taeda* and *P. caribaea* as Affected by Site Conditions.

The next step taken was to study the effect of site conditions on the rates of growth of the two main species *P. taeda* and *P. caribaea*. The numerical data for *P. palustris* was too scanty to permit of its being analysed graphically.

Table V shows the effect of soil moisture on the rate of growth of the two species. The table was derived from a series of curves which are not reproduced here since all the relevant data are contained in the table.

TABLE V.

Age	Dry		Well Drained		Moist		Wet	
	P. tae	P. car	P. tae	P. car	P. tae	P. car	P. tae	P. car
Years	cf/ac.	cf/ac.	cf/ac.	cf/ac.	cf/ac.	cf/ac.	cf/ac.	cf/ac.
4	50	210	110	180	220	140	—	220
5	220	350	270	290	370	320	—	400
6	370	490	420	440	540	520	—	570
7	490	640	570	620	710	730	—	740
8	600	780	740	810	890	990	—	910
9	710	910	960	1,020	1,090	1,270	—	1,050
10	820	1,040	1,200	1,250	1,300	1,560	—	1,180
11	920	1,160	1,460	1,500	1,590	1,850	—	1,300
12	1,010	1,270	1,750	1,740	1,900	2,140	—	1,410
13	1,090	1,370	2,050	1,970	2,210	2,420	—	1,500
14	1,150	1,460	2,300	2,180	2,570	2,690	—	1,590
15	1,200	1,550	2,540	2,380	2,890	2,920	—	1,660

NOTE: There were not sufficient plots of *P. taeda* on wet sites for a curve to be drawn. The general trend of growth would probably approximate to that on very dry sites.

From this table it will be noted that there is little difference in the rate of growth of the two species on well drained and moist soils. Under extreme site conditions, however, *P. caribaea* by virtue of its greater tolerance shows markedly better growth than *P. taeda*.

The Inflence of Humus Content of the Soil on Rate of Growth

Soil fertility as determined by the humus content of the soil has a much more marked effect on the rate of growth of the two species than on their health. The volume per acre-age data presented in Table VI are derived from a series of curves which are not reproduced here.

TABLE VI.

Age	Old Forest Soils		Fynbos Soils		Veld Soils	
	P. tae	P. car	P. tae	P car	P. tae	P. car
Years	cf/ac.	cf/ac.	cf/ac.	cf/ac.	cf/ac.	cf ac.
4	110	320	50	240	30	100
5	400	480	230	340	160	200
6	700	680	460	450	280	300
7	980	1,000	550	560	390	400
8	1,260	1,380	680	680	490	500
9	1,530	1,720	800	810	590	620
10	1,770	2,020	890	940	670	740
11	2,010	2,250	960	1,070	750	850
12	2,220	2,460	1,030	1,200	810	950
13	2,440	2,670	1,090	1,310	870	1,040
14	2,610	2,850	1,150	1,410	930	1,100
15	2,770	3 030	1,200	1,490	970	1,160

It will be seen from this table that the growth rates of both species are considerably influenced by the humus content of the soil and that *P. caribaea* grows faster than *P. taeda* on all soils irrespective of their humus content. Though this conclusion is apparently contradictory to the results presented in Table V for well drained sites it should be remembered that Table VI shows figures representative of all site types and since *P. caribaea* is more tolerant to extremes of moisture it may be expected to yield a greater volume than *P. taeda* over a general average of all sites. That *P. caribaea* actually does yield a higher volume of timber per acre than *P. taeda* is borne out by the curves reproduced here (Fig. 7). These show general volume per acre-age trends for the three main Southern pine species on all sites in the Midland Conservancy.

A study of these curves shows that up to the age of 10 years there is little difference in the rate of growth of *P. taeda* and *P. caribaea,* but that after this age the increment rate of the former species begins to decrease and at the age of 20 years *P. caribaea* shows a considerably higher volume per acre.

The volume production of *P. palustris* on the other hand is rather less than half that attained by either of the other species at any age up to 20 years and this species would appear hardly economic as regards production of timber even when compared with other slow growing species such as *P. canariensis.*

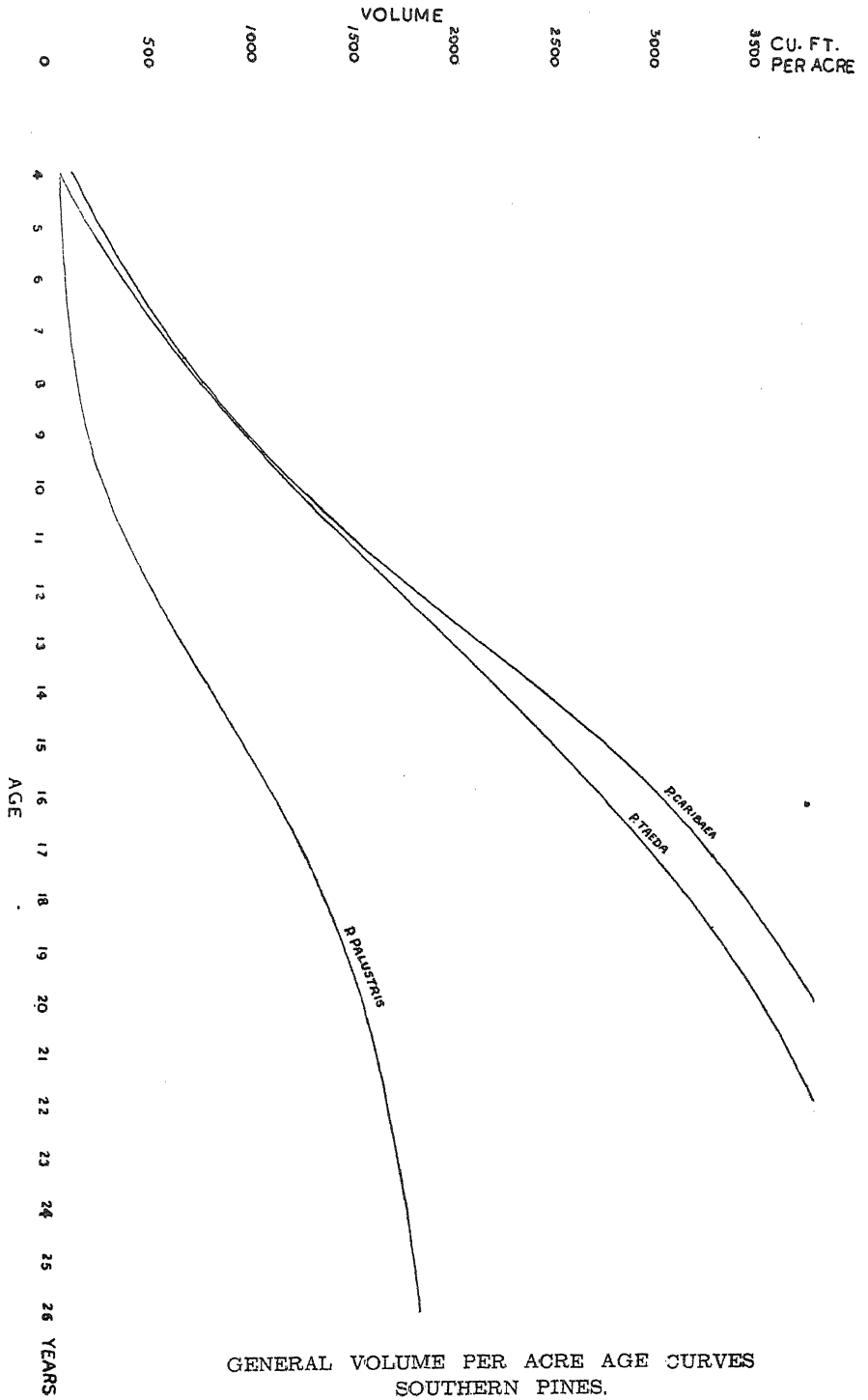
The Timber of the Southern Pines.

There is at present very little detailed information available regarding the relative strengths, working properties and durability of the timber of the Southern pines. Mill reports on young *P. taeda* however, indicate that in the Midlands this timber lacks many of the desirable qualities associated with *P. insignis.*

The timber of *P. caribaea* and *P. palustris* appears to be stronger and less short fibred than that of *P. taeda.* All these timbers lose a good deal of weight when seasoned to an air-dry condition.

General Conclusions.

From the foregoing it is apparent that *P. taeda* can be planted with any prospect of success only on well drained soils with an ample



GENERAL VOLUME PER ACRE AGE CURVES
SOUTHERN PINES.

moisture supply and a high humus content. Such soils are rare in the Midlands and constitute first quality site conditions for *P. insignis* to which species they would normally be planted. The ill health of *P. taeda* on all other sites and the quality of the timber it produces make it very doubtful whether further afforestation with this species is justified in the Midland Conservancy.

P. caribaea is rather more tolerant than *P. taeda* and should prove useful in afforesting the heavier soils on which *P. insignis* would probably not succeed. From general observation in mixed stands of *P. pinaster* (Portuguese) and *P. caribaea* made during the present study there is every indication that the former species will prove a faster grower than *P. caribaea* on many sites which are marginal for *P. insignis*. *P. pinaster* is healthier and faster growing than *P. caribaea* on dry shallow soils and is undoubtedly the logical species for such sites in the Midlands, but in many mixed stands even on moist sandy clay soils it was noticed that at the age of 6 years *P. pinaster* was already beginning to outstrip *P. caribaea* in height growth. In spite of this fact, however, it may be advisable to retain pure stands of *P. caribaea* on some of the best sites of this type, even though *P. pinaster* may prove to be slightly faster growing, in order to avoid the creation of large unbroken blocks of the latter species both for aesthetic reasons and to facilitate the combatting of any possible insect attack in the future.

In view of its tolerance under conditions of poor aeration and high soil water content, *P. caribaea* will probably remain the most suitable species for the afforestation of vlei sites and heavy poorly drained clay soils on which neither *P. insignis* nor *P. pinaster* will thrive. It should be borne in mind, however, that although *P. caribaea* will remain fairly healthy on sites of this type its volume production will be relatively low (see Table V column 9).

P. palustris, though apparently tolerant on a variety of sites, is so slow growing as to make its further planting unjustifiable except on an experimental scale in arboreta, etc.

Should further afforestation with *P. taeda* and *P. caribaea* be contemplated it is recommended that seed of the same origin as that of *P. taeda* Stock Nos. 7042, 7851 and 9442 and *P. caribaea* Stock No. 9481 be used, if procurable. From general observations made in a number of stands seed of these stocks appears to produce trees of good form and vigorous growth with straight stems and light branching under average conditions in the Midland Conservancy.

SUMMARY.

Observations were made on the rate of growth, health and form of the three main Southern Pine species, *P. caribaea, P. taeda* and *P. palustris* in plantations in that portion of the South-western Cape Province between George and Clarkson, included in the Midland Conservancy.

From the data collected it is concluded that *P taeda* requires light, moist soils rich in humus for healthy vigorous growth, and since *P. insignis* (*radiata*) will yield a greater volume of better quality

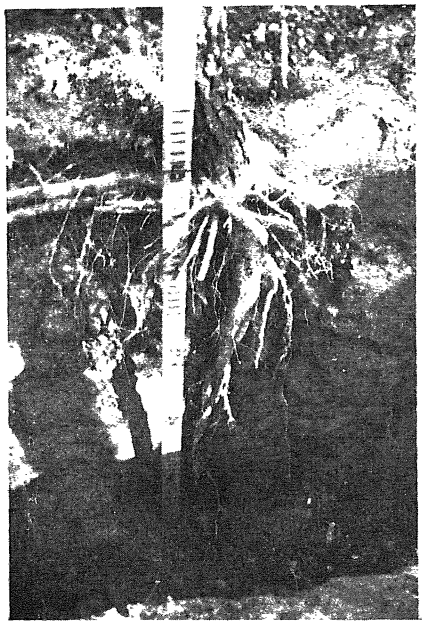


FIG. 1.—Typical *P. taeda* root system. Witelsbos.

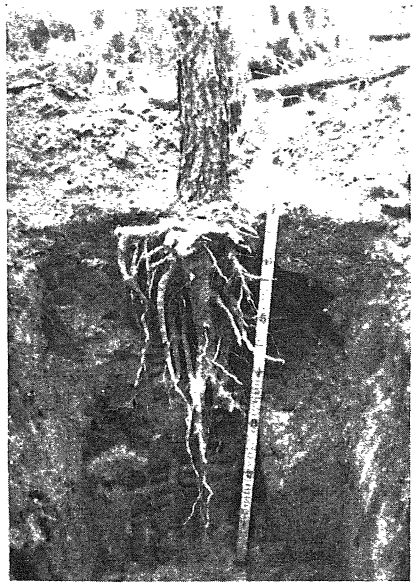


FIG. 2.—Typical *P. caribaea* root Storms River.

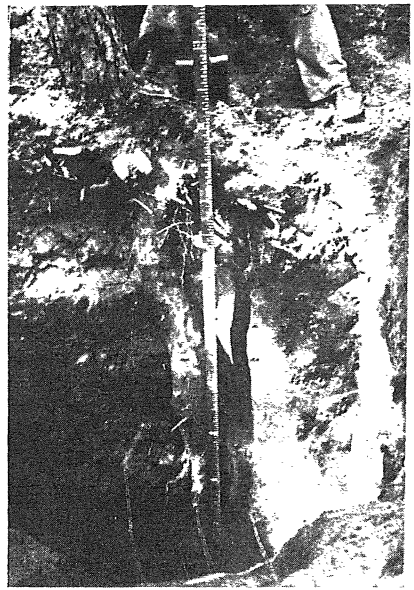


FIG. 3.—Typical *P. palustris* root system on deep soil. Kruisfontein

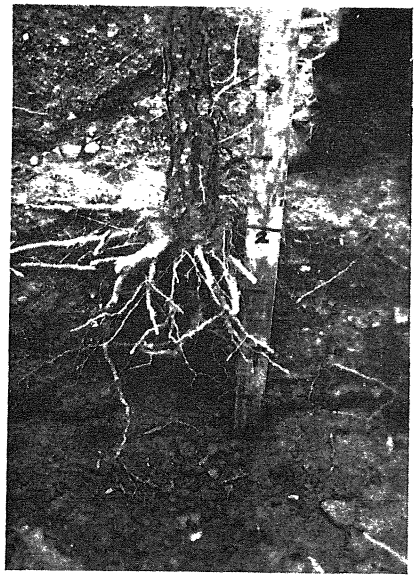


FIG. 4.—*P. taeda* root system on a shallow well drained soil. Blaauwkrantz.

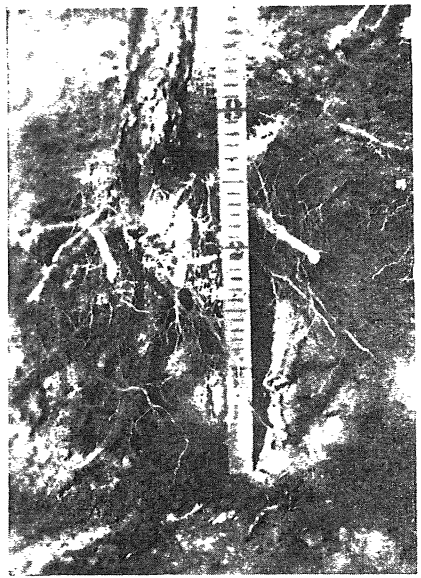


FIG. 5.—*P. caribaea* root system on a dry shallow soil. Witelsbos.

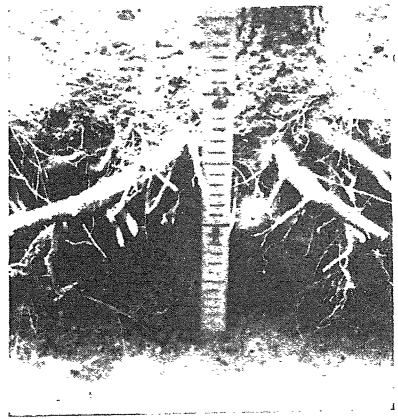


FIG. 6.—*P. palustris* root system on a shallow well drained rocky soil. Witelsbos.

timber on such sites the planting of *P. taeda* in this region should be discontinued.

P. caribaea and *P. palustris* are shown to be tolerant on a wide range of sites and the former species, in view of its ability to produce timber on ill drained vlei soils, is recommended for the future afforestation of such sites and also of the heavier, poorly drained clay soils.

In view of its extremely slow growth further afforestation with *P. palustris* is not recommended.

Reference.

Laughton F. S. Report on the Soils of the Midland Conservancy with Special Reference to the Growth of Pinus Species. (Unpublished).

L.S.G.

Reprinted from the
Journal of the South African Forestry Association
No. 1, October, 1938
Second Edition, August, 1944

SOUTH AFRICAN GROWN FURNITURE WOODS

By M. H. SCOTT

(*Senior Forest Products Officer, Division of Forestry.*)

THE vast bulk of furniture wood used in South Africa is imported from abroad. Our local resources, particularly as regards indigenous species, are small indeed, but exceedingly precious. Although under the most stringent management, our indigenous forests could never have produced sufficient timber to serve the purposes of factory production, excessive exploitation in the past has accentuated a natural scarcity, and it is only within recent years that management has been adjusted with a view to securing a small sustained yield from them. Many of the better known native timbers, quite apart from sentimental considerations, are essentially cabinet woods, and it is perhaps something to be thankful for that a costliness due to comparative inaccessibility, low conversion factor, due to poor form, and, in the case of certain of the more precious, unsoundness, tends to restrict their use as such.

In the past the reputation of the indigenous timbers for furniture making and other purposes has suffered severely owing to faulty handling and lack of proper seasoning, but the importance of correct conversion methods is now generally recognised and the confidence of the public has been more or less restored.

Although our indigenous forests are peopled by an almost unparalled variety of species, the number of well known furniture woods can be counted on the fingers of one hand. Brief descriptions of the better known, and some of the more obscure species, as well as of two fine introduced exotics, follow.

Stinkwood

Black Stinkwood, *Ocotea bullata*, holds pride of place over all South African grown species, whether indigenous or exotic. Few, if any, woods in the world are more beautiful than a piece of lustrous, well-figured, golden and black Stinkwood. The tree, which occurs principally in the forests of the Knysna District and the Transkei, produces average logs of good length and up to two feet in diameter, and, owing to an intense demand for the timber, hollow stems and smaller logs are also readily saleable. It is curious that so beautiful a timber should retain so unattractive a name. The alternatives, Laurel and Cape Olive, to which it is entitled, are seldom or never heard. Logs from older trees invariably contain a certain amount of semi-decayed wood near the centre, which for a short time after sawing emits a distinctly foetid smell which extends even to the neighbouring sound wood. The smell disappears with drying. The wood occurs in a variety of well blended colours. The younger, as well as many of the larger, fast grown, trees yield a wood that is almost white. The familiar brown to black markings may develop gradually with

age, or the whole tree change to a uniform grey or golden brown or black, or a combination of these colours, to which a wonderful natural sheen lends added beauty. When the annual rings are obliquely exposed in sawing, a handsome figure results. At times the wood bears a remarkable resemblance to selected Black Walnut. The texture is fine, and a high finish may be obtained. Weight per cubic foot, at ten per cent. moisture content, ranges from 38 to 62 pounds, averaging about 47. It is inclined to vary with the colour, the black being the heaviest.

Stinkwood is one of the most difficult of woods to season satisfactorily. Its shrinkage is high, averaging from ten to twelve per cent. linearly across the grain, and, particularly in the darker wood, is apt to corrugate badly in drying. Until quite recently it was used for almost all wagon parts, and, even to-day, in spite of its high price, is sought after for yokes and felloes. Little is wasted in the trade, ends and small pieces being converted into turned and polished fancyware. It is the most costly of all furniture woods in South Africa.

Kiaat

Following Stinkwood in popularity, especially in the Transvaal, comes a wood which until recently was little known outside its natural habitat. Kiaat, *Pterocarpus angolensis*, for some time recognised as a useful and durable timber not too difficult to work, was cut up for mine sleepers and numerous other rough uses until about ten years ago, when its high qualities as a furniture wood claimed general recognition.

The tree occurs mainly in the Eastern Transvaal Lowveld, East Africa and Rhodesia. Large logs are not common. The bole is generally short and often crooked, the average lengths of straight logs being about eight feet with diameters of about 14 inches.

The local timber, most of which is handled by the Forest Department, now enjoys the confidence of the public and orders exceed the available annual cut. Coming from smaller and often slightly crooked trees the figure of the Union timber is generally recognised as superior to the average imported wood.

When freshly worked the colour of the wood varies considerably from uniform light brown to dark brown with honey-coloured markings, but it tones down to a more uniform brown on exposure. It is a combination of the figure from the growth rings and the blending of the colours which make this wood so attractive.

The texture is inclined to be coarse, but a very fine finish can be obtained and the wood is only slightly more difficult to work than teak. It is exceptionally durable, even against white ants, and can be used with safety under very adverse conditions. In sizes used for furniture it is very easily seasoned and is one of the most stable woods, having an average linear shrinkage of only 1.5 per cent. from the green to the oven dry condition.

The sap wood which is usually about 1½ inches thick and straw coloured, has double the shrinkage of the heart. It is also readily attacked by borers and for safety sake is treated in zinc chloride or other preservative when included in any quantity in panelling, etc. It is largely a matter of taste as to whether the inclusion of sapwood improves the appearance of the wood, but there is no doubt that it certainly lends character to any furniture when properly matched.

YELLOWWOOD

Yellowwood (*Podocarpus falcatus, Podocarpus Henkelii,* and *Podocarpus elongatus*), although hardly correctly described as a furniture wood, has in the past always been associated with Stinkwood in furniture making. This is one of the most abundant of the local timbers, yielding logs up to three feet and over in diameter and 30 feet and more in length, and mention of it can hardly be omitted. This wood is the only coniferous species of any importance indigenous to the Union. It is of a uniform yellowish colour, finely textured, and fairly hard, weighing 33 (28-44) lbs. per cubic foot air dry. It is easily worked and gives a very fine finish, taking stain readily. It is difficult to air dry free of stresses and for fine work of any kind should be conditioned in a kiln.

EXOTIC SPECIES

There are two locally grown exotic timbers which deserve mention at this point. One is Saligna gum (*Eucalyptus saligna*) and the other Blackwood (*Acacia melanoxylon*). The former, a native of Eastern Australia, has been planted on a fairly large scale in the moist mountain and sub-tropical area of South Africa. The growth of this tree has been phenomenal in some parts of the country, but in spite of this the timber produced has not necessarily been soft or light in weight. An outstanding instance is the case of some 23-year old trees from the Northern Transvaal which reached a diameter of 26 inches at breast height and produced wood of an average weight of 52 lbs. per cubic foot. This is considerably heavier than the average 40 (27-59) lbs. recorded for this species in South Africa.

Although there is often a considerable amount of splitting in the logs, due to natural stresses unrelated to drying out, once the boards have been sawn they are readily seasoned without appreciable further defect developing. The average green moisture content of this timber is in the neighbourhood of 120 per cent. and the shrinkage to an air dry condition is 7 per cent. linear across the grain.

The colour of the wood varies from pink to red and on exposure turns to light or dark reddish brown. It is usually straight grained but may show a handsome figure as a result of cutting across the growth rings or on account of ribbon or fiddle back grain. Average Saligna is very similar to mahogany in many respects.

In working qualities, Saligna, when cut from large trees, compares with imported oak. It is comparatively low in price, and will no doubt come into great favour.

Blackwood (*Acacia melanoxylon*), is another Australian species introduced into South Africa on a smaller scale.

The wood varies in colour from almost black to a light grey and it has not been found possible to determine from outward appearance which trees produce the darker wood. There is usually a fairly wide, 1½ inch, white sap wood. The darker wood is more difficult to season satisfactorily owing to a tendency to corrugate, but on the whole the wood seasons fairly well. In general it is well figured mainly due to the growth rings but the value is sometimes reduced owing to the number of small knots and knot holes present. It closely resembles Stinkwood at times, and is

in fact substituted in some cases for the more valuable wood, though it lacks its characteristic sheen. It weights 42 (32-51) lb. per cubic foot air dry and is inclined to be tough to work.

A peculiar feature about certain shipments of Blackwood used for furniture, has been the exudation of minute drops of a black substance from scattered vessels and small areas in the ground tissue. This has not been sufficient to cause any inconvenience and becomes fixed when the wood receives its finishing coat.

Other Indigenous Species

Coming back to the indigenous timbers, Wit Els (*Platylophus trifoliatus*) is an easily worked hardwood timber used to a large extent in the Knysna districts for hotel and other furniture. The tree is locally fairly plentiful and is often in the form of gnarled coppice stumps. Originally prized for the curled grain obtainable from these old stems, it is now largely used on account of the comparative ease with which it works.

The colour of the wood varies from light brown to greenish brown, but it is often variously marked and can with care be matched to give a very pleasing effect. Normally the figure is not conspicuous and the texture is fine and even. The wood has a characteristic, almost sweet smell. Its weight is 37 (28-48) lb. per cubic foot, and it has a reputation for great durability.

Although the average normal shrinkage across the grain is only 6 per cent., Wit Els, especially in thicker sizes, is apt to collapse and shrink very unevenly. Its green moisture content is usually as high as 150 per cent.

Tambootie (*Spirostachys africanus*) which occurs mainly in the savannah forests of the Transvaal and Zululand is one of the most attractive of South African timbers but unfortunately is rare. Large trees are seldom sound and it is therefore difficult to get boards of useful size. The sapwood of which there is usually about 1½ inches, is white and is in great contrast to the very dark brown heart. The heart is beautifully figured and contains attractive dark markings. The wood has a strong, pleasant scent which it retains indefinitely, and reminds one of sandalwood. It is of fine texture and very heavy, 63 (60-67) lb. per cubic foot.

Its oily nature makes it less difficult to work than other woods of the same hardness and it turns very well.

It is a fairly stable wood, having an average linear shrinkage across the grain of only 3 per cent. from the green condition.

Owing to its attractive qualities it should be reserved for the very best class of furniture only.

In contrast to the dignified Tambootie are the rather showy "Boekenhouts." The Cape Beech (*Rapanea melanophleos*), the Transvaal Boekenhout (*Faurea saligna*) and Terblanz (*Faurea macnaughtonii*) with their markedly reticulate grain and conspicuous figure (when cut on the quarter) due to the very broad rays.

Cape Beech is well distributed from the Cape to the Transvaal and like Terblanz grows to fairly good size, often over two feet in diameter with a long straight bole. Terblanz, however, is rather restricted in its distribution, occurring only in the coastal forests of the Midland and

Eastern Cape. Transvaal Boekenhout, a small, bushy tree, the bole of which is seldom straight, is found most frequently in the Transvaal Bushveld

Terblanz is the heaviest and hardest of the three weighing 60 (55-63) lb. per cubic foot. It is dark brown and has a close texture with a slightly sweet smell when sawn or heated. On account of its weight it is not greatly used.

Cape Beech is very much lighter in colour, its weight too is less, being 50 (47-55) lb. per cubic foot. It has no scent.

Transvaal Boekenhout is generally coarser in texture than either of the above and shorter in the grain. It is often twisted and cross grained and has many natural defects, and is therefore less suitable for furniture though it is frequently used as such on farms situated within its habitat. Its weight is 47 lb. per cubic foot.

Wilde Sering (*Burkea africana*) another small tree of the Transvaal Bushveld, is a splendid furniture timber when obtainable in sufficient size, but as it is especially sought after for naves and other uses there is little available for the finer uses. The timber is very prettily marked and varies from yellowish brown to dark red with a handsome lustrous grain. It has a small shrinkage and the sapwood is often difficult to distinguish in the lighter coloured logs from the heart. The weight of the wood, which is exceptionally tough, is 45 (40-53) lb. per cubic foot.

Although also very limited in the quantity available, two other Transvaal timbers are worthy of mention owing to their special suitability for furniture making, and pieces at the Forest Products Institute made from these timbers have attracted much attention. The first is Wit Sering (*Kirkia acuminata*). This is a tree with a wide, light grey, sapwood and greenish brown heart. The wood has a most attractive figure due to the very numerous growth rings which are wavy and irregular. The result is a pleasing burr walnut effect.

Although, like gritty teak, severe on tools, it is comparatively light in weight, 37 (34-44) lb. per cubic foot, has a small (3 per cent.) shrinkage and it not difficult to season in thin sizes. Thicker sizes retain their moisture for exceptionally long periods.

The second, Berg Mahogany (*Entandrophragma caudatum*) is a dark brownish red wood, which owes its attractive figure to the numerous rings of parenchymatous tissue. This wood also has a wide whitish sapwood. It is easy to work and seasons readily when not naturally defective. When cut green it has an unpleasant sour smell but this disappears as the wood dries. The weight of the wood is 46 lbs. per cubic foot air dry. Ripple marks are more obvious than in almost any other wood examined.

Red Els (*Cunonia capensis*) is a wood which, unlike most of the other timbers mentioned, has not increased in popularity in recent years. This is probably very largely due to difficulty in obtaining a good finish by machines. The wood, which is usually a dull red, has little figure and a very even grain. Its weight is 45 (42-53) lb. per cubic foot.

Logs up to 30 inches diameter and 12 feet and over are available and the tree is comparatively abundant in the Cape forests.

Another abundant species in the Transvaal forests is Water Pear (*Eugenia gerrardi*). The wood is light brown to greyish brown in colour and is often prettily marked with reddish or yellowish tinges. The texture is

moderately fine and very even and the grain is pleasant though not prominently figured. Curly grain is quite characteristic. Furniture of light colour has been made of this wood. The weight is 43 (40-46) lbs. per cubic foot.

There are numerous other timbers from which very attractive furniture has been made, such as Matumi (*Adina galpini*) with its flame-like grain and yellow and brown markings; Red Currant (*Rhus legati*), with its characteristic red colour and beautiful sheen; Mzeri (*Bridelia micrantha*) with its birds eye figure; Essenhout (*Ekebergia capensis*), Cape Chestnut (*Calodendron capensis*), and Camdeboo Stinkwood (*Celtis rhamnifolia*), easily worked hardwoods for those who prefer a lighter colouring, but space does not permit of fuller descriptions.

Printed in the Union of South Africa
by L. S. Gray & Co. (Pty.), Ltd.,
13 Meikle Street, Johannesburg.

Reprinted from the
Journal of the South African Forestry Association
No. 1, October, 1938

THE PLACE OF WATTLE BARK IN THE LEATHER TRADE.

By J. D. M. KEET
(*Director of Forestry*)

THE art of leather-making dates from the earliest historic age. Even in the stone-age it is scarcely conceivable that man practiced the cult of sansculottism unless it be that he was protected by the hide of a dinosaur. Within quite recent times Eve did attempt to introduce the use of vegetable materials for feminine attire, but it is known that she soon reverted to the normal clothing of her period, and that this was furnished by the skins of animals. The primitive art of preserving and preparing skins by the use of vegetable tans was probably preceded by the use of animal fats. Alum and other mineral salts were later introduced as tanning agents and the use of chrome is comparatively recent. Formaldehyde, albumins, oils and now also synthetic tans are modern developments in the curing of leather. Synthetic tans, either individually or blended with other tans, are used in the manufacture of some of the finest quality leathers. Cost of production, for the time being, precludes their use on an extensive scale.

The manufacture of leather for contemporary requirements is no longer a simple art. In view of keen competition from substitutes, the successful leather manufacturer is a man of resource who bases his science upon constant experimentation and research. He has, in addition to a sound basic knowledge of chemistry and physics, a long and thorough experience in the manufacture of leather and in the manifold and constantly changing uses to which it is put in world markets.

It is essential that the tanner have access to supplies of hides and skins and of tanning materials suited to the production of the various leather types. Of even greater importance are standard of quality and price of raw material which will enable him to compete in world trade. Because of modern developments in transportation, the markets of all countries, except where barred by national economic policy, are within his reach; similarly his home markets are available to foreign competition.

Wattle bark and wattle bark extract are interchangeable with certain vegetable tans and are supplemented by others such as sumac and valonia. It may be accepted that wattle products will retain their place in the trade only so long as they maintain and improve their standard of quality and are subject to marketing at a competitive price. The use of extract is likely to increase in comparison with that of bark. This is due to the guaranteed standard quality of the former regarding its chemical properties, to the saving in freight and storage and to the ease with which extract can be blended and

its colours controlled and rectified. In wattle extract the percentages of tannic acid and non-tans are guaranteed to within 2-3 per cent. of a given standard, and the colours to within a narrow margin of points. In bark, on the other hand, there is a range of 14-15 per cent. in tannic acid and a comparatively wide range in non-tans and colours, both of which are important in tanning technique.

The tanning industry is developing in the direction of specialization which demands the use of tanning materials of known standard properties such as are yielded by extracts, mineral tans and certain vegetable tans. The tanner cannot readily adjust his method of tanning to suit each chemical variation in unstandardised ingredients. Each hide or skin has to be subjected to a regular flow through a series of vats containing a complex blend of liquors of various grades and strengths, each of which is designed to fulfil a specific function in the process of tanning. As the tanning of a hide may take several months, it will be realized why many tanners use extract and so avoid the risk involved by the use of tanning materials which vary in composition.

For these reasons it is of importance that growers, who on account of peculiar circumstances, wish to foster the use of bark in tanning, should produce a bark of high quality at a competitive price for each established grade. This is not a matter in which growers can afford to rest upon their laurels. The State can offer no further assistance than is provided at present through giving advice on the growing, harvesting and grading of bark. Its use will not be encouraged by lowering the standards of the established grades, or, still less, by the introduction of an additional grade of lower standard.

It is partly on account of the variations in the properties of wattle bark, due possibly to the age of the trees, silvicultural method, soil, climate, season, method of harvesting or other factors, that some growers favour the selling of bark upon the basis of the chemical analysis of each individual consignment. Militating against this proposal, apart from the question of cost, is the well-known fact that dry vegetable tanning materials are amongst the most difficult products from which to draw samples which will, on analysis, give results representing a fair mean of a consignment. Considerable difficulty has already been experienced in South Africa in the sampling of commercially ground and chopped bark. Research is now being undertaken to establish a sound and practical technique for securing bark samples for chemical analysis. In view of these facts the desirability of marketing bark overseas upon a basis of chemical analysis has still to be demonstrated.

The interests of the producers and exporters of wattle bark and hides and skins, tanners, manufacturers of leather goods and distributors of the finished products, are all interdependent, for they rely equally upon the success of the leather trade. Only through a sincere effort on the part of South African wattle growers to maintain and improve present standards of wattle products will it be possible to maintain or enchance the prospects of the South African wattle industry. As has already been emphasised, competition in the marketing of tanning materials is not local, but international.

Reprinted from the
Journal of the South African Forestry Association
No. 1, October, 1938

THE INFLUENCE OF AGE ON SUMMERWOOD RATIO IN PINE TIMBER.

A QUANTITATIVE CONSIDERATION OF APICAL INCIDENCE

By JOHN M. TURNBULL

(*Timber Mechanics Officer, Division of Forestry*)

THE simplest conception of the structural development of wood that is consonant with a definite correlation between summerwood percent. and rate of growth, involves constancy in absolute summerwood width from ring to ring. Its validity in certain circumstances has been established at the Forest Products Laboratory, at Princes Risborough, in England, by experiments on Sitka Spruce, in the course of which it was shewn (1) that summerwood percent at ordinary heights in stems of that species is proportionate to ring width. To what botanical extent this finding may apply has yet to be investigated and it is proposed in this paper to shew that, except in certain circumstances at ground level, proportionality does not apply to Pines.

The researches of Priestley (2), Chalk (3), and others, have established a significant relationship between the alternation of spring- and summerwood development and foliar activity; and Kolmodin (7) draws attention to striking differences in the foliar development of Pine and Spruce. He asserts that Spruce differs from Pine in that its needles and shoots are full-grown simultaneously; whereas, those of Pine remain undeveloped until the shoot is full-grown. Needles of Pine internodes that have developed during the previous year, therefore, are active factors during the greater part of the growing season in the development of the tree. This means that the influence of needle development in Spruce is brought to bear on the development of the tree as a whole a year earlier than in Pine. In regard to Pine, the writer has elsewhere (4) attempted to shew that springwood development is dependent mainly on reserve nourishment stored up by the tree during the previous year. In both genera, summerwood increment is controlled by current climatic conditions, so that while in the case of Pine, the two types of tissue contributing to a year's radial increment are dependent on conditions prevailing in separate years, Spruce is affected by the continuous conditions of the current year. This marked difference in the manner of development of the two genera might well account for their widely varying response to rate of growth; and, incidentally, would seem to discount the value of Pine material in attempts to correlate annual radial increment with rainfall.

In Pine it has been found that in winter rainfall regions in South Africa, absolute summerwood width at ground level is in close correlation with precipitation during the months of January

to March (4), and that the correlation varies from place to place inversely with the local mean precipitation for that period. There are, moreover, indications that the correlation varies locally according to the extent to which topography and edaphic factors affect the availability of a given precipitation for tree assimilation. In other words in an area over which a uniform precipitation prevails the correlation varies directly with run-off. The conclusion that may be drawn is that in circumstances in which available moisture in the least favourable years satisfies the assimilative capacity of a Pine tree, absolute summerwood width at ground level, just as in Spruce, tends towards constancy.

In the case of Spruce, however, the tendency is maintained over a considerable range in relative height; whereas, as will be shewn, it ceases in Pine at any appreciable height. In this genus, instead of remaining more or less constant at such heights, the tendency is for absolute width to increase radially in successive rings, outwards. Were absolute summerwood width in individual rings to remain constant throughout the length of the incremental sheath, it is clear that radial constancy would, as in Spruce, be maintained at higher levels. The different behaviour in Pine, or at least in such species of that genus as have so far been investigated, is attributable to what has been called apical incidence.

Apical incidence has been described (4) as the transverse projection of a tendency in the summerwood incremental sheaths to taper in ascent. As each successive sheath in outward progression is longer than its inner neighbour, successive sheaths become intercepted at any cross-cut relatively nearer their bases, and accordingly their widths at the cross-cut approach nearer to the maximum width found at ground level. When, as in the absence of any fortuitous circumstance, summerwood width at ground level is constant, a progressive increase in width ensues. In other circumstances, the influence is sufficiently strong to secure a progressive relative increase.

At the laboratories at Pretoria West, the tapering tendency in summerwood sheaths has been found in stems of *Pinus taeda, P. patula,* and *P. insignis.* In no stem examined has it been absent. Data in respect of fifteen stems, representing four different species of American Southern Pine, analysed at the Madison Laboratories in America (5) has been plotted by the writer to secure the results illustrated in figure 1, from which it will be seen that the tendency for summerwood percent to vary steadily with height in the case of each stem is both marked and similar both in direction and degree. Direction indicates a diminution, and can be attributed only to ascending diminution in width of individual sheaths. The tapering tendency has thus been found in seven species, and has been absent in no stem of any species examined or in respect of which data is available. Generalisation in respect of the genus *Pinus* would accordingly appear to be justified. Age, dimensions, and summerwood percent at both ends of the merchantable bole of the Madison stems will be found in the table. For percentages at intermediate heights the reader is referred to the original article (5). The dotted lines in figure 1 will be explained in the discussion on figure 2 which follows.

SUMMER WOOD PERCENT, AND CERTAIN OTHER DATA, FOR 15 AMERICAN SOUTHERN PINE STEMS.

Tree	Species	Age yrs.	Total height ft.	Data for merchantable bole at							
				Base				Tip			
				length ft.	Diam. in.	Ring Count	Summerwood percent	length ft.	Diam. in.	Ring Count	Summerwood percent
1	P. palustris	32	55	0	11.3	5.6	25	52	3.6	5.0	46
2	,,	23	45	0	8.0	5.8	44	36	3.0	4.0	52
3	,,	89	60	0	11.1	13.8	30	57	4.7	13.8	72
4	,,	105	68	0	15.1	16.4	17	67	4.2	12.2	53
5	P. echinata	36	52	0	11.4	6.3	22	46	3.2	4.8	50
6	,,	35	53	0	11.4	6.1	22	52	3.7	3.8	45
7	,,	74	53	0	12.1	12.0	39	46	5.3	10.0	54
8	,,	77	57	0	12.6	12.8	29	62	4.3	5.8	53
9	P. caribaea	16	50	0	9.6	3.3	34	41	3.4	2.4	61
10	,,	21	56	0	9.6	4.5	30	46	4.1	3.5	58
11	,,	69	54	0	11.2	12.3	30	52	3.2	10.7	64
12	,,	89	80	0	12.6	14.2	30	77	4.4	11.7	71
13	P. taeda	26	62	0	20.7	2.5	36	52	6.0	3.4	54
14	,,	22	46	0	15.6	3.0	22	31	8.1	2.6	48
15	,,	52	69	0	13.2	7.7	23	62	4.1	5.9	58

Figure 2 is a conception of apical incidence as applying diagrammatically to one half of a vertical median section of a stem, shewing its quantitative implications at the interceptions made by twenty equally spaced cross-cuts with the same number of periodic radial increments. To obviate confusion by overloading the diagram, the summerwood zones are not drawn, but their relative thicknesses at all interceptions are indicated by the summerwood percentages that would result at such points by virtue of the proportionality of sides of similar triangles. Values at any point are represented by the following expression :—

$$\frac{p\ (m-n)}{m}$$

where p = value at ground level (in this instance, 40%).

m = number of periodic increment concerned.

n = number of cross-cut above ground level, concerned.

Along the right-hand side of the figure, the mean percentage along the radius concerned is indicated against each cross-cut. These successive means from butt to tip have been plotted, and the resulting figure for sake of comparison shewn in figure 1 against the plottings of the Madison stems.

The remarkable similarity disclosed between actual and diagrammatic trends is highly significant. The reconciliation is reinforced by a comparison of the diagrammatic stem in figure 2 and Trendelenberg's figure ([6]) shewn in the inset thereto. Trendelenberg demarcates his Larch stem into regions of varying specific gravity, ascending from A, upwards; while the theoretical diagram is divided up in similar succession of summerwood percent, between which and density a close correlation exists. It will be noticed that in each case the regions diverge from a more or less common centre near the middle of the stem at ground level. Region A, in Trendelenberg, is not actually pith, but merely the lightest portion encountered, and presumably includes pith. The separation of this region conveys the idea that the sections examined were not central throughout the stems' length, and that had they been, the two portions would have coalesced to form a light central stele.

Summary

The principle of apical incidence, which, it is claimed, determines the regional variation in summerwood percent in a stem, is explained, and quantitatively examined. The conclusions yielded are illustrated diagrammatically, and the diagrams used to demonstrate that the observed manner of density distribution in the wood of Pine stems is reconcilable with the principle.

REFERENCES.

(1) PHILLIPS, E. W. J. : Forest Products Laboratory, Princes Risborough. Project 10. "Investigation of the relation between the structure, chemical composition, and the physical properties of timber." Mimiograph Progress Report No. 6, 1936.

(2) PRIESTLEY, J. H. : "Studies in the Physiology of Cambial Activity, iii. The Seasonal Activity of the Cambium." *New Phytologist*, Vol. xxiv. No. 5. 8 December, 1930.

(3) CHALK, L. : "The Formation of Spring and Summerwood in Ash and Douglas Fir." *Clarendon Press*, Oxford. 1930.

(4) TURNBULL, JOHN M. : "Variations in Strength of Pine Timbers." *S.A. Journal of Science*. Vol. xxxiii, 1937, pp. 653-682.

(5) BRAY, M. W. and C. E. CURRAN : "Sulphate Pulping of Southern Yellow Pines. Effect of growth Variables on yield and Pulp Quality." *Paper Trades Journal*. CV/20. November, 1937.

(6) TRENDELENBERG, R. : "Die Eigenschaften des Holzes und ihre Erforschung." *Das Bayerland*. Vol 47/17. May, 1936.

(7) KOLMODIN, GUSTAF : "Influence of Climate on Diameter growth of Pine." Translation from the Swedish by S. P. Langmack, May, 1935. U.S.A. Forest Service (Division of Silvics) Translation No. 258.

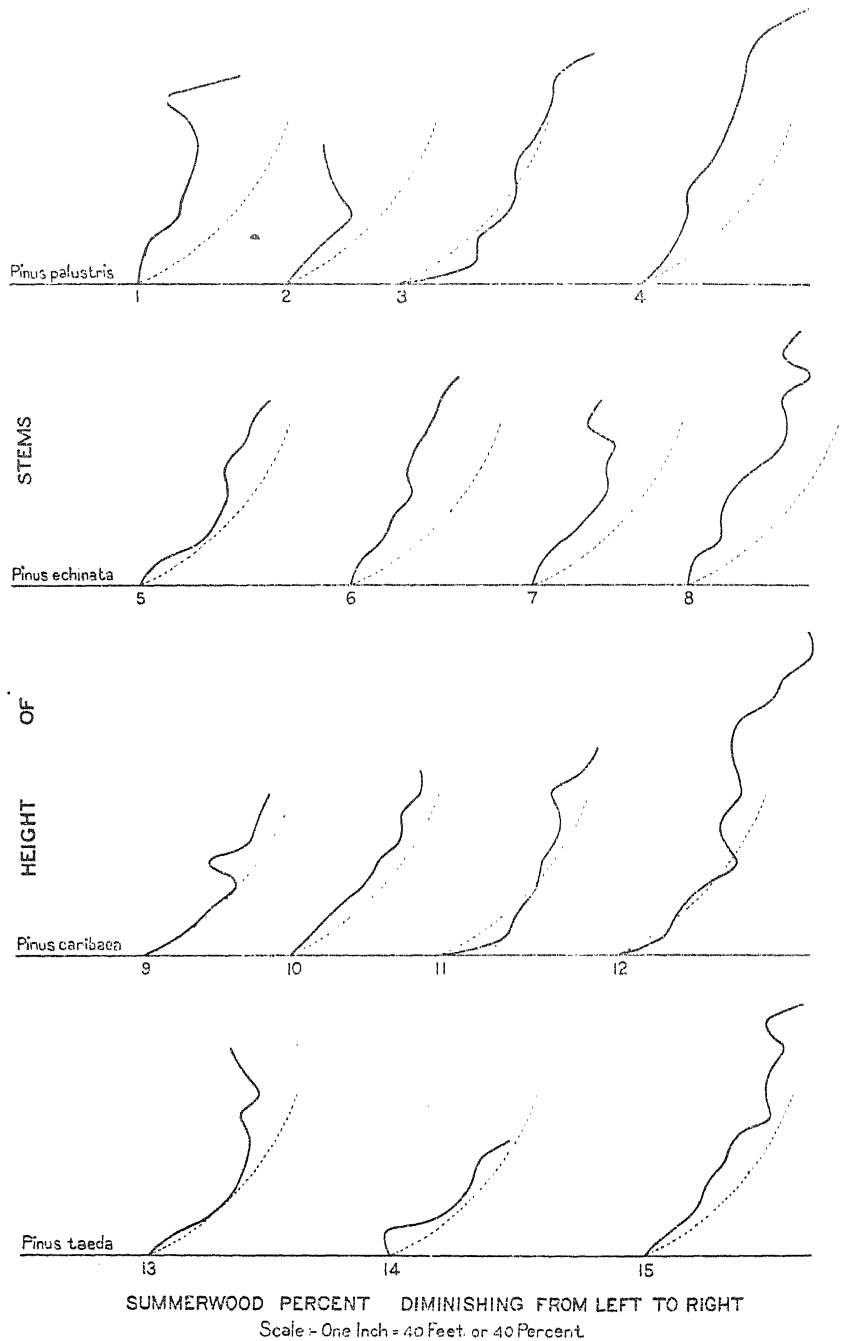
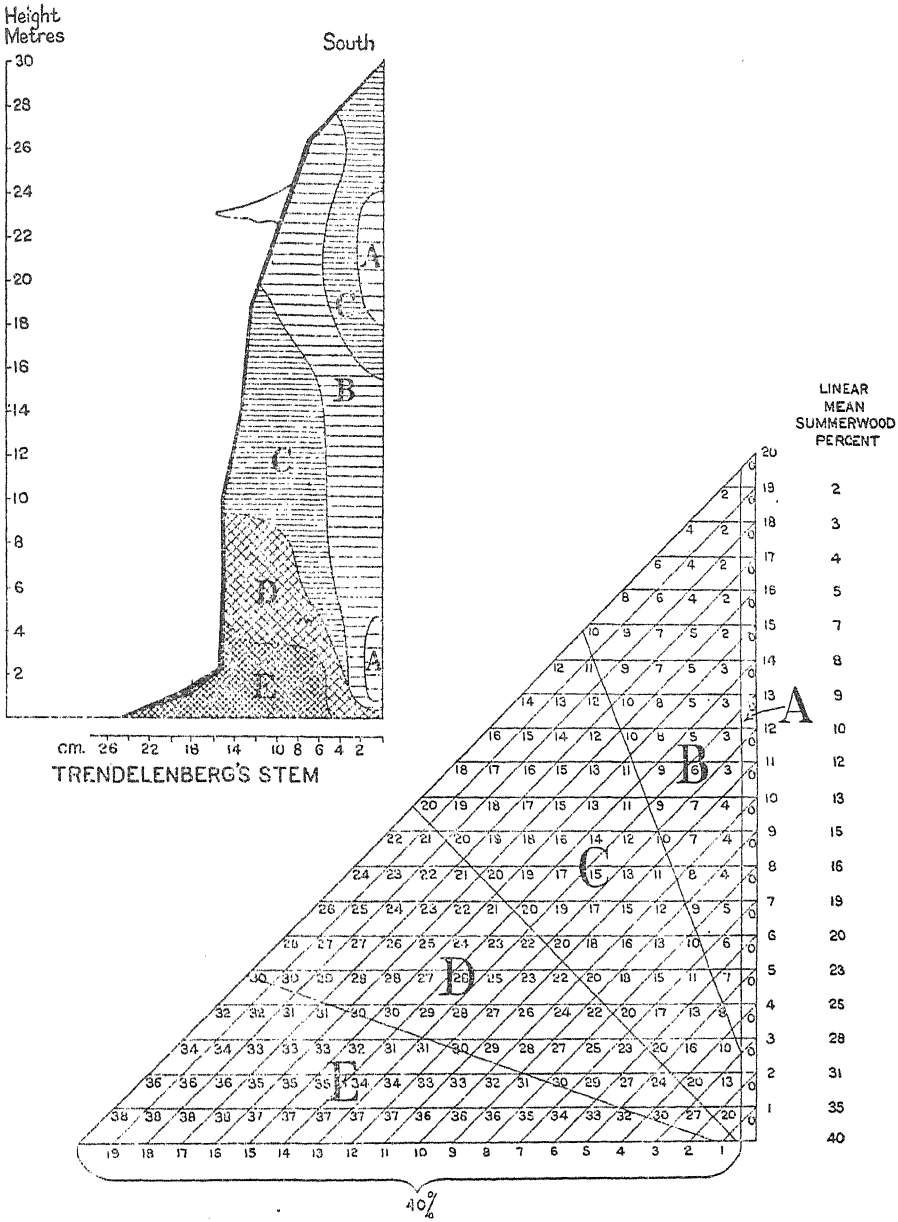


FIG. 1.—Trend of Summerwood percent variation with height of merchantable stem in respect of fifteen trees analysed at the Forest Products Laboratory, Madison, U.S.A. Dotted curve represents theoretical trend based on figure 2.



QUANTITATIVE IMPLICATIONS OF APICAL INCIDENCE

Horizontal lines represent cross cuts.
Sloping lines represent limits of periodic increments.
Figures at intersections indicate theoretical summerwood percent.

FIG. 2.—Theoretical Summerwood percent in twenty rings or groups of rings computed in respect of twenty evenly spaced crosscuts, assuming a constant percent of forty at ground level.

The

Journal of the South African Forestry Association

Index

TO NUMBERS 1 TO 10 — 1938-1943

PUBLISHED BY THE ASSOCIATION

Die

Tydskrif van die Suid-Afrikaanse Bosbouvereniging

Inhoudsopgawe

VIR UITGAWES 1 TOT 10 — 1938-1943

UITGEGEE DEUR DIE VERENIGING

PRETORIA
1943

THE JOURNAL OF THE SOUTH AFRICAN FORESTRY ASSOCIATION

INDEX

NO. 1 TO 10 — 1938-1943

Compiled by
JOHN M. TURNBULL

EXHAUSTIVENESS, as in a book index, has not been attempted in the present compilation, which is intended primarily as an alphabetical register of authors and titles of articles that have been published in the first ten issues of the *Journal*. A liberal quota of detail has, nevertheless, been selected for incorporation on the basis of significance or extent of the passages, names or words under reference.

Titles of articles, including editorials, original articles, correspondence and reviews are entered both verbatim and inverted. Each verbatim title is allotted a serial, and each relevant serial is quoted against the name of the author concerned. Besides inclusion in the general alphabeticization, authors' names, with the relative serials, are, for convenience sake, repeated under the headings "Authors of original articles," " Correspondents," " Reviewers," " Skrywers van oorspronklike artikels," or " Korrespondente." The status of all subsidiary articles is indicated by the word " Editorial," " Letter," " Review," " Redaksioneel," or " Brief," enclosed in brackets at the end of each title entry. Where no such indication occurs, the title is that of an original article.

All titles, whether verbatim or inverted, are printed in capitals; authors' names in lower case heavy face; and detail in lower case light face. The heavy face figures in the marginal references indicate the issue concerned, and the light figures, the page.

As all stocks of the orange coloured paper so familiarised to readers hitherto as a cover to the *Journal* are now exhausted, ordinary issues will in future be provided with covers manufactured from a locally-made green paper. The colour of the present publication will thus indicate to what run of the *Journal* the index refers.

DIE
TYDSKRIF VAN DIE SUID-AFRIKAANSE BOSBOUVERENIGING

INHOUDSOPGAWE

NO. 1 TOT 10 — 1938-1943

Opgestel deur

JOHN M. TURNBULL

IN hierdie inhoudsopgawe het die samesteller nie gestreef na uitvoerigheid, soos in dié van 'n boek nie. Die hoofdoel was die bewerking van 'n alfabetiese register van skrywers en titels van artikels wat in die eerste tien uitgawes van die *Tydskryf* verskyn het. Nogtans is 'n ruime mate van détail bygebring ten opsigte van belangrikheid of omvang van gedeeltes, name of woorde waarna verwys word.

Opskrifte van artikels, waarby inbegrepe is redaksie-artikels, oorspronklike stukke, korrespondensie en resensies, word sowel verbatim as onder herrangskikking weergegee. Elke verbatim opskrif het 'n volgnommer, en elke betreklike volgnommer verskyn teenoor die naam van die betrokke skrywer. Hoewel die name van skrywers tesame met hul volgnommers op die algemene alfabetiese lys voorkom, word hulle gerieflikheidshalwe onder die hoofde ,,Skrywers van oorspronklike artikels,'' ,,Korrespondente,'' ,,Authors of original articles,'' ,,Correspondents'' of ,,Reviewers'' herhaal. Die aard van alle bykomende stukke word aangedui deur die woord ,,Redaksioneel,'' ,,Brief,'' ,,Editorial,'' ,,Letter'' of ,,Review'' tussen hakies aan die end van elke opskrif. Waar geen sodanige aanduiding voorkom nie, is die opskrif dié van 'n oorspronklike artikel.

Elke opskrif is in hoofletters gedruk, sowel waar dit verbatim as waar dit onder herrangskikking weergegee word; name van skrywers in gewone letters, vet druk; détail in gewone letters, gewone druk. Die syfers in vet druk onder die randverwysings aan die regterkant dui op die betrokke uitgawe, en die syfers in gewone druk gee die bladsy aan.

Omdat alle voorrade van die orangekleurige omslagpapier van die *Tydskryf*, wat reeds so bekend geword het, tans opgebruik is, sal toekomstige gewone uitgawes 'n omslag hê van plaaslik vervaardigde groen papier. Die kleur van hierdie publikasie sal derhalwe aandui op watter uitgawes van die *Tydskryf* dit betrekking het.

Abdoolskloof 3.71
Abura 10.37
Acacia cyanophylla 2.6
cyclopis 2.6
dealbata, bark of 10.48
decurrens, bark of 10.48
melanoxylon 1.43, 44
mollissima, bark of 10.40
saligna 2.6
Acanthopsyche junodi 10.8
1 ACCLIMATIZATION OF FRESHWATER GAME FISH IN THE CAPE PROVINCE AND ITS RELATION TO FOREST AREAS. A. Cecil Harrison. 4.5
Ackerman, D. P., 16
Adamson, R. S. 1.64
Adina galpini 1.46
Administrator of the Transvaal, the late 1.1
Afara 10.37
Afforestation in South Africa, species used 1.12
AFFORESTATION AFTER THE WAR, STATE. I. J. Craib 9.5
African mahogany 10.37
African walnut 10.37
2 AFRIKAANSE BOSBOOMNAME. C. L. Wicht 5.41
Afzelia africana 10.39
Agba 10.37
Albert Falls disease 2.35, 4.41
Algaroba 4.78
Alstonia congensis 10.39
Ambrosia beetle 10.11
3 AMPTELIKE TAALGEBRUIK. (Redaksioneel) 8.2
Analysis, statistical qualitative 7.76
Anaphoidea nitens 10.5
4 ANATOMIE DE LA FEUILLE CHEZ LES PINS MARITIMES. V. Fieschi; and CLASSIFICATION DES PINS MARITIMES. V. Fieschi *et* H. Gaussen. (Review by E. K. M.) 3.119
Andrews, E. T. E., 168
Andrews, Thomas 4.6
ANNUAL REPORT OF THE DIVISION OF FORESTRY FOR THE YEAR ENDED 31ST MARCH, 1938. (Review) 2.79
ANNUAL REPORT OF THE DIVISION OF FORESTRY FOR THE YEAR ENDED 31ST MARCH, 1941. (Review by C. E. Legat) 9.59
Anti-stain solutions 8.98
5 ANTI-STAIN SOLUTIONS. A. Quiding & Son. (Letter) 10.60
Apical incidence 1.53
6 APPEAL FROM CHINA, AN. (Editorial) 4.2
7 APPROACH TO THE STUDY OF RAINFALL INTERCEPTION BY FOREST CANOPIES, AN. C. L. Wicht 6.54
Araucaria braziliana, restriction in use of name 7.2
8 ARBOR DAY ADDRESS, AN. J. J. Kotze 5.73
Arderne 1.14
Area of timber producing forests in Union 1.5
Arseenoksiede 3.86
Arsenious oxide 2.17
Assegai 1.24
9 ASSOCIATION'S PUBLICITY STAMP, THE. (Editorial) 5.3
Aucoumea klaineana 10.39
10 AUSTRALIAN FORESTRY, Vol. 5, No. 1. (Review) 5.98
AUTHORS OF ORIGINAL ARTICLES. See also CONTRIBUTORS.
[Anonymous], 141
Ballenden, S. St. C., 164
Craib, I. J., 140, 143, 154
Davis, D. H. S., 126
Eckbo, Nils B., 46
Goldschmidt, W. B., 111
Gunn, Mary, 136
Harrison, A. Cecil, 1
Hey, D., 39

Keet, J. D. M., 106, 119
King, N. L., 44, 63, 83, 87, 123, 162
Kotze, J. J. 8, 96, 99
Krogh, P. M. D., 12, 71
Laughton, F. S., 100, 120
Ledeboer, M. S. J., 31
Loock, E. E. M., 22
Loseby, P. J. A., 65, 88, 91, 113, 118
Luckhoff, H. A., 62
Marsh, E. K., 80
Miller, O. B., 11, 93
N[eethling], E. J. 173
O'Connor, A. J., 171
O'C[onnor], A. J., 13
Pearse, D. W., 152
Read, H. A., 42, 185
Reinecke, O. S. H., 130
Reitz, Deneys, 50
Schiemer, E. L., 59
Scott, M. H., 35, 75, 117, 135, 138, 158, 170
Sherry, S. P., 98, 121
Smith, C. A., 96
Stephens, R. P., 90, 111
Taylor, A. J., 56
Tooke, F. G. C., 115
Turnbull, John M., 26, 45, 71, 72, 110, 125, 147, 150
van der Merwe, C. C., 91
van Wyk, J. H., 113, 160
Verwoerd, Len, 160
V[erwoerd], L., 173
White, Phil, 86
Wicht, C. L., 7, 28, 33, 47, 130, 174
Wroughton, F. H., 19

Bagworm 10.4
Ballenden, S. St. C., 76, 164
11 BANTU AS FOREST BOTANIST, THE. O. B. Miller 4.21
Bark beetles 10.11
Bark beetles in imported timber 8.2
Bass, American largemouth black 8.4
Bass, smallmouth black 7.12
Bass, stocking with 7.27
Bateson, R. A. 3.123
12 BEDREIGING VAN HOUTWURM-AANVAL IN BOUHOUT EN DIE VOORKOMING DAARVAN, DIE. P. M. D. Krogh 9.51
13 BEGINNING OF FORESTRY EDUCATION IN SOUTH AFRICA, THE. A. J. O'C. 3.108
14 BEKKER, THE LATE S. P. (Editorial) 1.1
Belville drift sands, commencement of reclamation of 1.6
Belvitan paste 9.23
Bennett, H. H. 6.104
Benvie 1.15
Berg mahogany 1.46
15 BEROEP OP MEDEWERKERS, 'N. (Redaksioneel) 6.2
16 BESOEK AAN DIE VERENIGDE STATE SE BOSPRODUKTE LABORATORIUM TE MADISON, 'N. D. P. Ackerman 4.75
Beukenhout 1.25
Biesievlei 3.70
17 BIG TREES (Editorial) 5.3
Black wattle bark 10.46
Blackwood 1.43, 44
Blanford, H. R. 2.3
BLOEKOM, DIE HOUWHOEKSE (Redaksioneel) 10.3
Bluegill sunfish 8.6
BLUEGUM, THE HOUWHOEK (Editorial) 10.3
Bom, 151

Bombax pentandra 10.34
Boosmansbos 5.38
BOSBOOMNAME, AFRIKAANSE. C. L. Wicht 5.41
Bosboukloof 3.70
Bosboukloof stream hydrograph 10.14
BOSPRODUKTE LABORATORIUM TE MADISON, 'N BESOEK AAN DIE VERENIGDE STATE SE. D. P. Ackerman 4.75
Bostrychid beetles 10.12
BOTANIST, FOREST, THE BANTU AS. O. B. Miller 4.21
Bowen, J. W. 6.104
Braambos 5.38
BRAZIL, AN INTERLOPER FROM. M. H. Scott 5.29
Brazilian walnut 5.30
18 BRAIR PIPES. (Editorial) 5.2
Bridelia micrantha 1.46
Bridge over Rhine, Caesar's 9.2, 55
Brown, Dr. J. Croumbie 1.6
Bryant, R. C. 3.118
Buffels grass 7.51
Bunyoro, the Makama of 1.3
Burkea africana 1.45
19 BURMA TEAK AND ITS EXTRACTION. F. H. Wroughton 5.5
Burton, R. C. 1.8, 4.15

Cabinda 10.36
20 CAESAR'S BRIDGE. (Editorial) 9.2
21 CAESAR'S BRIDGE. J. P. R. Wallis. (Letter) 9.55
Calodendrum capense 1.46
Caloposoma acaciae 10.10
Camdeboo stinkwood 1.46
Cameroons, timbers of the 10.30
Canarium schweinfurthii 10.39
Canela 7.2
Cape beech 1.45
Cape chestnut 1.46
CAPE FLATS, RECLAMATION OF THE. AN ARBOR DAY ADDRESS. J. J. Kotze 5.73
Card sorting 10.58
Carlson, K. A. 1.8, 9
Carlson, K. A., 40, 116, 179
22 CAROB OR LOCUST TREE (CERATONIA SILIQUA), THE. E. E. M. Loock 4.78
Carp 8.9
Case-hardening 8.97
Ceiba 10.37
Ceiba pentandra 10.39
Celtis rhamnifolia 1.46
(CERATONIA SILIQUA), THE CAROB OR LOCUST TREE. E. E. M. Loock 4.78
Ceroplesis thunbergii 2.35
23 CHAIRMEN, OUR. (Editorial) 9.1
CHAIRMAN, VICE-, APPOINTMENT OF. (Editorial) 9.1
24 CHANGES AT FORESTRY HEADQUARTERS. (Editorial) 10.1
CHARCOAL, WOOD, MODERN METHODS OF MANUFACTURE OF. P. J. A. Loseby *and* C. C. van der Merwe 9.31
Checking, surface 8.96
Chestnut tannin extract 6.76
CHINA, AN APPEAL FROM. (Editorial) 4.2
Chlorophora excelsa 10.39
Chromium salts 6.78
Clarke, A. 3.109
CLASSIFICATION DES PINS MARITIMES. V. Fieschi. (Review by E. K. M.) 3.119
Clayton, Col. J. B. 1.9
"Cluster pine" *versus* "Pinaster pine" 6.98

Cluver, E. H., 149
Coile, T. S. 3.119
Collar rot 2.37
COMMERCIAL PURPOSES, TREE-PLANTING FOR. N. L. King 8.37
Common yellowwood 1.21
CONCRETE, WOOD *versus* STEEL AND. (Editorial) 1.2
Congo timbers 10.29
Constantia 4.18
CONTRIBUTORS. See AUTHORS OF ORIGINAL ARTICLES, CORRESPONDENTS, and REVIEWERS. Sien ook MEDEWERKERS.
Coopers Hill Forest School 1.8
Copaifera sp. cf. *arnoldiana* 10.39
Correspondencies 7.76
CORRESPONDENTS. See also CONTRIBUTORS
Andrews, E. T. E., 168
Ballenden, S. St. C., 76
Carlson, K. A., 40, 116, 179
Cluver, E. H., 149
Guy, G. L., 58, 89
Interested, 172
Keet, J. D. M., 29
King, N. L., 108
K[ing], N. L., 172
Laird, 172
Leith, Gordon, 144
Lita, 30
Monniker, 180
Quiding, A., & Son, 5
Read, H. A., 41, 112
Stapleton, C. C., 27
Struben, Frank, 105
Wallis, J. P. R., 21
Cottonwood 7.79
Craib, I. J. 3.121
Craib, I. J., 140, 143, 154
C[raib], **I. J.**, 107, 146, 176
Creosote 2.16
CREOSOTE, SOUTH AFRICAN, THE TOXICITY OF. J. H. van Wyk *and* Len Verwoerd 1.47
25 CROSS-SHAFT OVERHEAD FAN KILN, A. (Review by N. B. E.) 7.83
26 CROSS-SECTION DIMENSIONAL ADJUSTMENT OF SUBSTITUTE TIMBERS. John M. Turnbull 3.111
Crude oil 2.16
27 CULTIVATION OF INDIGENOUS PLANTS, THE. C. C. Stapleton. (Letter) 5.81
Cunonia capensis 1.24, 46
CURRENT MONTHLY RECORD OF FOREST LITERATURE. (Editorial) 2.2
Curtisia faginea 1.24
Cutch 6.78
Cutting season 2.17, 8.74

Dam construction 6.5
Dam maintenance 6.10
Damages to an immature plantation, assessment of 6.49
Dams, improvement of for fish culture 6.4
Dams, stocking of with fish 8.4
Davis, D. H. S., 126
DAVY, JOSEPH BURTT, SOUTH AFRICA'S DEBT TO. Mary Gunn 5.10
de Fin, Baron 1.6, 7
de Geus, H. L., 102
DE HOEK PLANTATION, TEMPORARY TIMBER CHUTES AT. D. W. Pearse 2.72
de Rêgné, Count de Vasselot 1.6, 8
de Wet, D. R., 55

DENDROLOGY, TEXTBOOK OF, COVERING THE IMPORTANT FOREST TREES OF THE UNITED STATES AND CANADA. W. S. Harlow *and* E. S. Harrar. (Review by E. J. N.) 3.118
Density distribution in pine and spruce stems contrasted 9.26
28 DEPLETION OF GROUND-WATER FLOW IN JONKERSHOEK STREAMS. C. L. Wicht 8.50
Desch, H. E. 1.65
29 DESTRUCTION OF NATIVE FORESTS IN NORTHERN ZULULAND. J. D. M. Keet. (Letter) 3.115
30 DESTRUCTION OF NATIVE TREES BY LANDOWNERS. Litt. (Letter) 7.80
31 DEVELOPMENTS IN PATHOLOGICAL RESEARCH ON WATTLES. M. S. J. Ledeboer 4.30
Dijkmans, M. A. F. 2.3
Discolouration in timber 8.97
32 DISTINCTION FOR THE JOURNAL. (Editorial) 3.3
33 DIURNAL FLUCTUATIONS IN JONKERSHOEK STREAMS DUE TO EVAPORATION AND TRANSPIRATION. C. L. Wicht 7.33
Divi-divi 6.77, 79
34 DIVISION OF FORESTRY'S ANNUAL REPORT. (Editorial) 9.4
DIVISION OF FORESTRY, ANNUAL REPORT FOR THE YEAR ENDED 31.8.38. (Review) 2.79
DIVISION OF FORESTRY, ANNUAL REPORT FOR THE YEAR ENDED 31.3.41. (Review by C. E. Legat) 9.59
DOKTORSGRADE IN DIE BOSBOUWETENSKAP. D. R. de Wet. (Letter). G. Hartwig (Letter) 4.82
Dormehl, P. J. 1.8
Douala 10.30
DRAADHEINING TE KOMATIPOORT, OPRIGTING VAN 'N. H. L. de Geus 5.12
Drift Sands, Belville 1.6
DRIFT SANDS, PORT ELIZABETH, RECLAMATION OF THE. N. L. King 2.5
Dumoria heckelii 10.39
Durability, South African grown timbers classified according to 2.27
Duursaamheid van onbehandelde Suid-Afrikaanse gekweekte hout 3.95
Dwyer, E. B. 1.8, 2.8

Eckbo, N. B. 1.11, 10.2
Eckbo, Nils B., 46
E[ckbo], **N. B.**, 25, 157
EDUCATION IN SOUTH AFRICA, FORESTRY, THE BEGINNING OF. A. J. O'C. 3.103
Eelworms in wattles 2.39
Eerste River hydrograph 10.15
Ekebergia capensis 1.26
Ekki 10.38
35 ELECTRIC MOISTURE-IN-TIMBER METERS. M. H. Scott 3.100
36 ELEMENTARY FOREST MENSURATION. M. R. K. Jerram. (Review by E. J. N.) 3.117
Elephant's Eye Stream 4.20
Elephants, teak-working 5.6
Ellis, J. D. 4.6, 7
Emily's worm 6.98
Emmental 10.20
37 EMPIRE FORESTRY ASSOCIATION, THE. (Editorial) 2.3
38 EMPIRE FORESTRY JOURNAL, THE. (Review) 4.86
Entandrophragma angolense 10.39
caudatum 1.46
congoense 10.39
cylindricum 10.39
macrophyllum 10.39
utile 10.39
ENTOMOLOGY, FOREST, PROGRESS OF, IN SOUTH AFRICA. F. G. C. Tooke 10.4
Eriodendron anfructuosum 10.39

Erythrophleum guineense 10.39
ivorensis 10.39
Essenhout 1.26
39 ESTABLISHMENT AND MAINTENANCE OF FRESHWATER FISH IN SOUTH AFRICA, THE. D. Hey 6.4, 7.4, 8.4
Eucalyptus globulus 10.3
EUCALYPTUS PLANTER, A PIONEER. Frank Struben. (Letter) 5.93
Eucalyptus saligna 1.43, 3.113, 5.90
40 EUCALYPTUS SALIGNA—MINIMISATION OF WASTE. K. A. Carlson. (Letter) 5.84
41. EUCALYPTUS SALIGNA—PLEA FOR A LONG TERM POLICY. H. A. Read. (Letter) 4.81
42 EUCALYPTUS SALIGNA AND SOIL RECLAMATION. H. A. Read 7.50
EUCALYPTUS SALIGNA, THE UTILISATION OF. M. H. Scott 4.46
Eucalyptus snout beetle 10.5
EUCALYPTUS SPECIES GROWN IN SOUTH AFRICA, A KEY TO THE. E. K. Marsh 3.16
Eucalyptus species, restricted use of in State afforestation 1.12
Eugenia gerrardii 1.46
Eulophonotus myrmeleon 5.28
Euproctis chrysorrhea 10.9
terminalis 10.7
European forest labour settlements 1.11
E[vans], I. B. P., 134
Evaporation 3.77
43 EVIDENCES OF RACIAL INFLUENCE IN A 25 YEAR TEST OF PONDEROSA PINE. (Review by S. P. S.) 6.102
44 EXPLOITATION OF THE INDIGENOUS FORESTS OF SOUTH AFRICA, THE N. L. King 6.26

Fagara macrophyllum 10.39
Falcate yellowwood 1.21
"Falcate yellowwood" *versus* "Henkel yellowwood" 6.98
Faurea macnaughtonii 1.25, 45
saligna 1.45
Felling season 2.17, 8.74
Fertilisation of fishing waters 6.13, 8.13
45 FIBRIL BEHAVIOUR AS DISCLOSED BY SHRINKAGE OBSERVATIONS. John M. Turnbull 5.62
Field, J. F. 9.23
Fieschi, V. 3.119
46 FIFTEEN YEAR'S MARKETING RESEARCH IN SOUTH AFRICAN TIMBERS. Nils B. Eckbo 9.48
Fire damage, relative susceptibility of exotic conifers to 5.99
Fire, resistance of wood to 1.2
Fish, dietetic value of 8.19
Fish, forage 8.15
FISH, FRESHWATER, THE ESTABLISHMENT AND MAINTENANCE OF, IN SOUTH AFRICA. D. Hey 6.4, 7.4, 8.4
FISH, FRESHWATER GAME, THE ACCLIMITISATION OF IN THE CAPE PROVINCE AND ITS RELATION TO FOREST AREAS A. Cecil Harrison 4.5
Fish, preparation of for the table 8.21
Fisheries, inland, the economic importance of 8.18
Fishery, the care and management of a 7.29
"Flow duration" curve 10.21
Forage for fish 6.15
Forest Act, Cape, No. 28 of 1888 ..... 1.7
Forest Act, Union, No. 16 of 1913 ..... 1.7
47 FOREST INFLUENCES RESEARCH TECHNIQUE AT JONKERSHOEK. C. L. Wicht 3.65
Forest Products Institute 1.11
48 FOREST PRODUCTS INSTITUTE. (Editorial) 10.2
Forest and Veld Conservation Act No. 13 of 1941 ..... 6.1
49 FORESTS AND EROSION. E. P. Stebbing. (Review) 8.123

50 FORESTS OF NORTHERN ZULULAND, THE. Col. Deneys Reitz 1.28
FORESTERS, GOVERNMENT, IMPROVED STATUS OF. (Editorial) 2.4
51 FORESTRY ABSTRACTS. (Review) 3.125
FORESTRY, DIVISION OF, ANNUAL REPORT FOR THE YEAR ENDED 31.3.38. (Review) 2.79
FORESTRY, DIVISION OF, ANNUAL REPORT FOR THE YEAR ENDED 31.3.41. (Review by C. E. Legat) 9.59
FORESTRY AT THE WITWATERSRAND SHOW. (Editorial) 4.3
Forsaith, C. C. 7.55
52 FOUNDATIONS OF SILVICULTURE UPON AN ECOLOGICAL BASIS. (Review by E. J. N.) 1.64
Fourcade, Dr. H. G. 1.9
Franzina's Rust Plantations 5.84
French Equatorial Africa Timbers 10.29
Froghopper damage 2.37
Frost resistance, relative, of small and large nursery plants 5.98
Fuel oil 2.16
Fungi, importation of timber infected by 9.3
FURNITURE WOODS, SOUTH AFRICAN GROWN. M. H. Scott 1.41
53 FUSED NEEDLE DISEASE AND ITS RELATION TO THE NUTRITION OF PINUS. (H. E. Young. (Review by S. P. S.) 6.100

Gaboon timbers 10.30
Galpin, E. A. 7.3
54 GALPIN, THE LATE E. E. (Editorial) 7.2
Gambier 6.77, 79
Gambusia top-minnows 8.11
Garcia 1.15
Garratt, G. A. 4.86
Gaussen, H. 3.119
Gedu nohor 10.37
Geike 1.15
Geldenhuys, Dr. F. E. 1.11
Gilliland, H. B. 5.36
55 GOEDKOOP DOKTORSGRADE. D. R. de Wet (Letter). G. Hartwig (Letter) 4.82, 84
Gold mines, production of timber for the 1.15, 4.63
Goldschmidt, W. B., R. P. Stephens *and,* 111
Gonimbrasia tyrrhea 10.9
Gonioma camassi 1.24
Gonipterus scutellatus 10.5
Gossweilerodendron balsamifera 10.39
Gower, A. E. 3.109
56 GRADING AND SAMPLING OF WATTLE BARK, THE. A. J. Taylor 8.103
Grandfather's wood 5.34
Green wattle bark 10.48
57 GROOT BOME. (Editorial) 6.2
Groot Schuur 1.15
Grootvadersbosch Forest 5.32
GROUNDWATER FLOW IN JONKERSHOEK STREAMS, DEPLETION OF. C. L. Wicht 8.50
58 GROWING EUCALYPTUS SALIGNA. G. L. Guy. (Letter) 3.113
59 GROWING OF POPULUS DELTOIDES IN SOUTH AFRICA, THE. E. L. Schiemer 5.17
Guarea cedrata 10.39
Gummosis 2.32, 4.30
Gunn, Mary, 136
Guy, G. L., 58, 89

60 HANDBOOK OF STRUCTURAL TIMBER DESIGN. I. Langlands *and* A. J. Thomas. (Review) 5.97
Hare, T. 2.6
Harison, Capt. C. 1.5, 6, 8
Harrison, A. Cecil, 1
Harrar, E. S. 3.118

Harlow, W. M. 3.118
Hartwig, G., 55
Haswell 1.5
61 HEALTH OF THE SOUTHERN PINES IN THE MIDLAND CONSERVANCY, THE. S. P. Sherry 1.30
Heliothrips haemorrhoidalis 10.9
Hemlock 6.78, 79
Henkel, C. C. 1.7
Henkel, J. S. 1.8, 3.109
"Henkel yellowwood" *versus* "Falcate yellowwood" 6.98
Hey, D., 39
Heywood, A. W. 1.7
Hill, Claremont, the 1.14
62 HISTOLOGICAL DISTRIBUTION OF WATTLE BARK TANNIN. H. A. Luckhoff 10.40
63 HISTORICAL SKETCH OF THE DEVELOPMENT OF FORESTRY IN SOUTH AFRICA. N. L. King 1.4
Hoeing as protection against rodents 8.68
Hollerith machine 10.58
Holley, J. Hunt. Charcoal kiln design 9.39
Honeycombing 8.97
HOUTINVOER, DIE UNIE SE. (Editorial) 3.2
64 HOUTMAKER EN DIE DROOGTE, 'N. J. D. M. K. 1.27
65 HOUTPRESERVERING. J. H. van Wyk *en* P. J. A. Loseby 3.81
Houtpreservering, ekonomie van 3.98
HOUTWURM-AANVAL IN BOUHOUT EN DIE VOORKOMING DAARVAN, DIE BEDREIGING VAN. P. M. D. Krogh 9.51
66 HOUWHOEK BLUEGUM, THE. (Editorial) 10.3
67 HOUWHOEKSE BLOEKOM, DIE. (Redaksioneel) 10.3
Hoyt and Troxell 10.20
Hunt, G. M. 4.86
Hutchins, Sir D. 1.7, 3.109, 4.15
Hydrographs 10.13
Hydrological experiment, Jonkershoek 3.73
Hylastes opacus 10.11

Indigbo 10.37
Imbuia 5.29
Imbuia, restriction in use of name 7.2
IMMATURE PLANTATION, THE VALUE OF AN. A. J. O'Connor 7.78
68 IMPERIAL FORESTRY BUREAU. (Editorial) 2.2, 3.3
69 IMPORTATION OF TIMBER. (Editorial) 9.3
70 IMPROVED STATUS OF GOVERNMENT FORESTERS. (Editorial) 2.4
71 IMPROVISED POLE-TESTING MACHINE, AN. John M. Turnbull *and* P. M. D. Krogh 3.103
Indigenous forests, classification of 8.24
forests, disposal of wood from, 1912/42 ..... 9.6
INDIGENOUS FORESTS, NOTES ON THE SYLVICULTURE OF THE. F. S. Laughton 8.24
INDIGENOUS FORESTS, THE PRESERVATION OF. H. A. Read. (Letter) 7.79
INDIGENOUS FORESTS OF SOUTH AFRICA, THE EXPLOITATION OF THE. N. L. King 6.26
INDIGENOUS PLANTS, THE CULTIVATION OF. C. C. Stapleton. (Letter) 5.81
INDIGENOUS TREE SPECIES, THE RAISING OF TRANSPLANTS OF. F. S. Laughton 1.17
INDIGENOUS TREES, STATE POLICY REGARDING. Gordon Leith. (Letter) 5.93
72 INFLUENCE OF AGE ON SUMMERWOOD RATIO, THE. John M. Turnbull 1.53
73 INFLUENCE OF VEGETATION AND WATERSHED TREATMENT ON RUN-OFF SILTING AND STREAMFLOW, THE. (Review by C. L. W.) 6.103
Insects, importation of timber infested by 9.3
Insekte besmette hout 9.3

74 INTERCEPTION AND STEMFLOW IN A PINE PLANTATION. Kittredge, Loughead *and* Mazurak. (Review by C. L. W.) **7.84**
Interested, 172
75 INTERLOPER FROM BRAZIL, AN. M. H. Scott **5.29**
76 INTRODUCTION OF POPULUS DELTOIDES TO SOUTH AFRICA. S. St. C. Ballenden. (Letter) **7.79**
77 INVOER VAN HOUT. (Editorial) **9.3**
Iroko **10.37**
Ironwood **1.23**
Irvingia bateri **10.39**

JAVA, A VISITOR FROM. (Editorial) **2.3**
Jacobs, M. R. **5.96**
Jerram, M. R. K. **3.117**
Johnson, T. H. Knikformule **7.55**
JONKERSHOEK, FOREST INFLUENCES RESEARCH TECHNIQUE AT. C. L. Wicht **3.65**
JONKERSHOEK STREAMS, DEPLETION OF GROUND-WATER FLOW IN. C. L. Wicht **8.50**
JONKERSHOEK STREAMS, DIURNAL FLUCTUATIONS IN. C. L. Wicht **7.34**
JONKERSHOEK STREAMS, THE VARIABILITY OF. C. L. Wicht **10.13**
78 JOURNAL, THE. (Editorial) **2.1**
JOURNAL, DISTINCTION FOR THE. (Editorial) **3.3**
Journal of the South African Forestry Association, the. Latest date for submitting articles **6.3**
JOURNAL, THE SCOPE OF THE. (Editorial) **4.1**
79 JOURNAL IN WAR TIME, THE. (Editorial) **9.4**

Kamassi **1.24**
Kapseisoen **3.87**
Keet, J. D. M. 1.11, 3.109, 4.10, 9.1, 10.1
Keet, J. D. M., 29, 106, 119
K[eet], **J. D. M.,** 64
Keet, J. H. **5.39**
Kessell, S. L. **6.100**
80 KEY TO THE SPECIES OF EUCALYPTUS GROWN IN SOUTH AFRICA. E. K. Marsh **3.16**
Khaya anthotheca **10.39**
grandifoliola **10.39**
grandis **10.39**
ivorensis **10.39**
Kiaat **1.42**
KIAAT, THE PROPERTIES AND USES OF SOUTH AFRICAN. M. H. Scott **7.61**
KILN, A CROSS-SHAFT OVERHEAD FAN. (Review by N. B. E.) **7.83**
Kilns, seasoning **8.81**
King, N. L., 44, 63, 83, 87, 108, 123, 162
K[ing], **N. L.,** 172
81 KINGWILLIAMSTOWN HARBOUR. (Editorial) **2.4**
Kirkia acuminata **1.45**
Kittredge, J. **7.84**
Klainedoxa latifolia **10.39**
Kluitjes Kraal Plantation, establishment of **1.6**
82 KNIKFORMULES IN DIE ALGEMEEN MET SPESIALE VERWYSING NA 'N NUWE VERGELYKING. H. L. Malherbe **7.53**
83 KNYSNA FORESTS AND THE WOODCUTTER PROBLEM, THE. N. L. King **3.7**
Komatipoort **5.12**
KORRESPONDENTE. Sien ook MEDEWERKERS.
Bom, 151
de Wet, D. R., 55
Hartwig, G., 55
Korstian, C. F. 1.64, 3.119
Kotze, J. J. **5.36**
Kotze, J. J., 8, 96, 99

Kreosoot 3.85, 9.53
Krogh, P. M. D., 12
Krogh, P. M. D., John M. Turnbull *and*, 71

Laird, 172
Lake improvement for fish culture 6.17
Lambrechtsbosch 3.71
Land values, effect of site quality and accessibility on 9.12
Lane-Poole, C. E. 3.109
LANGEBERG FORESTS, NOTES ON SOME. Notes by THUNBERG *and* J. J. KOTZE 5.32
Langlands, I. 5.97
Langrivier 3.71
Languages, official, anomaly in use of 7.2
Latham, James, Ltd. 1.2
La Tour, Ernest 4.6
Laughton, F. S., 100, 120
Leaf shedding in wattles 2.39
LEATHER TRADE, THE PLACE OF WATTLE BARK IN THE. J. D. M. Keet 1.51
Ledeboer, M. S. J., 31
Legat, C. E. 1.9, 2.3, 3.3, 9.4
Legat, C. E., 167
Leith, Gordon, 144
Leopoldville 10.29
Li, Y. K. 4.2
Lister, J. S. 1.6, 2.6, 7.80
Lita, 30
84 LOCAL TIMBER SUPPLIES AND THE WAR. (Editorial) 5.1
LOCUST TREE, THE CAROB OR, (CERATONIA SILIQUA). E. E. M. Loock 4.78
LOMBARDY POPLAR, A SEMI-EVERGREEN FORM OF. O. S. H. Reinecke *and* C. L. Wicht 9.19
Loock, E. E. M., 22
Lophira alata 10.39
procera 10.39
Loseby, P. J. A. 5.67
Loseby, P. J. A. 88, 118
L[oseby], P. J. A., 161, 181
Loseby, P. J. A., *and* C. C. van der Merwe, 91
Loseby, P. J. A., J. H. van Wyk *and/en*, 65, 113
Loughead, H. J. 7.84
Lovoa klaineana 10.39
Luckhoff, H. A., 62
85 LUMBER: ITS MANUFACTURE AND DISTRIBUTION. R. C. Bryant. (Review by E. J. N.) 3.118
86 LUMBER MILLERS AND SHOOK MANUFACTURERS GET TOGETHER. Phil White 9.44
Lyctus 10.12, 34

Maclean, Lachlan 4.6
McNaughton, C. 1.8
Macrolobium dewevrei 10.39
species 10.39
MADISON, 'N BESOEK AAN DIE VERENIGDE STATE SE BOSPRODUKTE LABORATORIUM TE. D. P. Ackerman 4.75
Mahogany, Berg 1.46
Makore 10.38
Malherbe, H. L., 82
MANAGEMENT STUDIES OF THE MAIN EXOTIC CONIFERS GROWN IN SOUTH AFRICA. I. J. Craib 2.49
Mangrove 6.77, 79
Mansonia altissima 10.39
Mansonia 10.38

87 MANUBI FOREST, THE. N. L. Illing 4.24
Marketing development 10.2
MARKETING RESEARCH IN SOUTH AFRICAN TIMBERS, PAPERS WITH S. N. B. Eckbo 9.48
Marsh, E. K., 80
M[arsh], **E. K.**, 4
Matadi 10.29
Matumi 1.46
Mazurak, A. 7.84
MEDEWERKERS. Sien SKRYWERS VAN OORSPRONKLIKE ARTIKELS en KORRESPONDENTE. See also CONTRIBUTORS.
Melia azedarach 2.70
Merensky, Dr. Hans 7.50
Metaalsoute 9.53
Metarbela sticticosta 10.10
88 METHOD OF STACKING POLES IN RESTRICTED YARDS, A. P. J. A. Loseby 3.110
Mexican pines, introduction of into South Africa 1.9
Mice in plantations 8.64
Miller, O. B., 11, 93
Millettia laurentii 10.39
Milward, R. C. 2.3
Mimusops heckelii 10.39
Mining timber 1.15
89 MINING TIMBER. G. L. Guy 2.77
Mining timber, size classes of 4.67
90 MINING TIMBER IN SOUTH AFRICA WITH SPECIAL REFERENCE TO WATTLE SILVICULTURE. R. P. Stephens 4.55
Mitragyna macrophyllum 10.39
stipulosa 10.39
91 MODERN METHODS OF WOOD CHARCOAL MANUFACTURE. P. J. A. Loseby *and* C. C. van der Merwe 9.31
MODULUS OF RUPTURE AND WEIGHT IN SOUTH AFRICAN GROWN PINE TIMBER, THE RELATIONSHIP BETWEEN. John M. Turnbull 7.67
MOISTURE-IN-TIMBER METERS, ELECTRIC. M. H. Scott 3.100
Molsburger, Dr. E. C. 5.32
Mond- en klouseer 5.12
Mongosi Forest 1.28
Monniker, 180
Morrison, Professor J. T. 6.54
Moshal, S. 9.44
Musanga smithii 10.39
Myrobalans 6.76, 79
Mzeri 1.46

Napier fodder 7.51
92 NATIVE ATTITUDE, THE. (Editorial) 1.3, 2.3
Native Land and Trust Act 1.28
93 NATIVE NAMES IN USE IN SWAZILAND FOR TREES, SHRUBS AND OTHER PLANTS. O. B. Miller 6.89
NATIVES, WEANING THE, FROM THE NATURAL FORESTS IN THE NATIVE TERRITORIES. K. A. Carlson. (Letter) 2.75
Needham, J. G. (Quoted) 6.4
N[eethling], **E. J.**, 36, 52, 85, 153, 175
N[eethling], **E. J.** *and* **L. V**[erwoerd], 173
94 NEW DEPARTURE, A. (Editorial) 4.2
95 NEW FOREST ACT, THE. (Editorial) 6.1
New Guinea, the timber industry in 5.99
Newberry 1.15
Nigerian timbers 10.29
96 NOMENCLATURE OF THE SOUTH AFRICAN YELLOWWOODS. J. J. Kotze *and* C. A. Smith 10.23
NOMENCLATURE, STANDARD, FOR SOUTH AFRICAN GROWN TIMBERS, A. 5.75
97 NONQUASSIE. (Editorial) 4.3
98 NOTE ON THE VEGETATIVE REPRODUCTION OF PINUS INSIGNIS. S. P. Sherry 9.23

99 NOTES ON SOME LANGEBERG FORESTS. By THUNBERG *and* J. J. KOTZE 5.32

100 NOTES ON THE SYLVICULTURE OF THE INDIGENOUS FORESTS. F. S. Laughton 8.24

Nudaurelia cytherea 10.7

NUWE OMSLAG, ONSE. (Redaksioneel) 3.3

Nygmia phaerrhea 10.9

Oak-bark 8.77, 79

Oak-wood 6.77

Obeche 10.38

O'Connor, A. J. 9.1, 56, 10.1

O'Connor, A. J., 171

O'C[onnor], **A. J.**, 13

O'Connor, E. J. 3.109

Ocotea bullata ..... 1.22, 41, 3.2 ,5.29, 7.1

Odontionopa sericea 10.11

Ohlssen, Anders 4.6

Olea laurifolia 1.23

OMSLAG, ONSE NUWE. (Redaksioneel) 3.3

101 ONSE NUWE OMSLAG. (Redaksioneel) 3.3

Opepe 10.38

102 OPRIGTING VAN 'N DRAADHEINING TE KOMATIPOORT. (H. L. de Geus 5.12

103 ORGANIZATION OF SAWMILLING INTERESTS. (Editorial) 9.2

Oxford School of Forestry 1.10

Pachylobus pubescens 10.39

Pachypasa albofasciata 10.10

capensis 10.10

PAPER-MAKING, PULP AND, AS A SOUTH AFRICAN INDUSTRY. P. J. A. Loseby 2.56

Parana pine, restriction in use of name 7.2

Parker, J. C. 4.6

PATHOLOGICAL RESEARCH ON WATTLES, DEVELOPMENTS IN. M. S. J. Ledeboer 4.30

PATHOLOGY, WATTLE, A PRELIMINARY REPORT ON SOME ASPECTS OF. R. P. Stephens *and* W. B. Goldschmidt 2.31

Pearse, D. W., 152

Perch 8.7

Phillips, Sir Lionel 1.15

Phoebe porosa 5.29, 7.1

Phoenix reclinata 3.113

Phorocantha semipunctata 10.6

Phytohormones 9.23

Picea excelsa, stem profile of 9.26

"Pinaster pine" *versus* "Cluster pine" or "Maritime pine" 6.98

Pine brown-tail moth 10.7

104 PINE NUTRITION. S. L. Kessell *and* T. N. Stoate. (Review by S. P. S.) 6.100

Pine stem profile 9.26

Pine thrips 10.9

Pin-hole borer 10.11

Pinus caribaea 1.30, 8.40

insignis 1.6, 11, 8.39

PINUS INSIGNIS, A NOTE ON THE VEGETATIVE REPRODUCTION OF. S. P. Sherry 9.23

Pinus insularis 8.41

longifolia 8.41

maritima 3.120

mesogeensis 3.120

palustris 1.30, 8.41

patula 8.40

pinaster 6.98, 8.39

Pinus pinaster, races of 3.119
pseudostrobus 8.41
PINUS RADIATA DON, EXPERIMENT WITH CUTTINGS OF. M. R. Jacobs. (Review by I. J. C.) 5.96
Pinus taeda 1.30, 8.40
teocote 8.41
105 PIONEER EUCALYPT PLANTER, A. Frank Struben. (Letter) 5.93
Pipes, tobacco 5.2
Piptadenia africana 10.39
106 PLACE OF WATTLE BARK IN THE LEATHER TRADE, THE. J. D. M. Keet 1.51
107 PLANT COMPETITION IN FOREST STANDS. C. F. Korstian *and* T. S. Coile. (Review by I. J. C.) 3.119
108 PLANT SUCCESSION ON THE TRANSKEIAN COAST. N. L. King. (Letter) 3.113
Platypus dispar 10.34
Platylophus trifoliatus 1.44
Platypodidae 10.11
109 PLEA TO CONTRIBUTORS, A. (Editorial) 6.3
Podocarpus falcatus 1.21, 43, 6.98
henkelii 1.21, 43
latifolius 1.19, 43
PODOCARPUS SPECIES, NOMENCLATURE OF. C. A. Smith 10.23
Pointe Noire 10.30
POLES IN RESTRICTED YARDS, A METHOD OF STACKING. P. J. A. Loseby 3.110
POLE-TESTING MACHINE, AN IMPROVISED. John M. Turnbull *and* P. M. D. Krogh 3.103
Policy, State afforestation, proposed revision of 9.16
Pond-field rotation 6.19
POPLAR, LOMBARDY, A SEMI-EVERGREEN FORM OF. O. S. H. Reinecke *and* C. L. Wicht 9.19
Poplars 8.37
POPULUS DELTOIDES, THE GROWING OF IN SOUTH AFRICA. E. L. Schiemer 5.17
POPULUS DELTOIDES, INTRODUCTION OF TO SOUTH AFRICA 7.79
Populus nigra L. var. *italica* du Roi 9.21
species 8.37
Port Elizabeth drift sands 1.8
PORT ELIZABETH DRIFT SANDS, RECLAMATION OF THE. N. L. King 2.5
Port Gentil 10.30
Port Harcourt 10.30
Port Jackson wattle 2.6
110 PRELIMINARY INVESTIGATION INTO THE CAUSES OF TORSION IN PINE STEMS. John M. Turnbull 8.112
111 PRELIMINARY REPORT ON SOME ASPECTS OF WATTLE PATHOLOGY. R. P. Stephens *and* W. B. Goldschmidt 2.31
112 PRESERVATION OF INDIGENOUS FORESTS. H. A. Read. (Letter) 7.79
PRESERVATION, WOOD. G. M. Hunt *and* G. A. Garratt. (Review by P. J. A. L.) 4.86
113 PRESERVATION OF WOOD, THE. J. H. van Wyk *and* P. J. A. Loseby 2.11
114 PRESERVERING VAN HOUT. (Redaksioneel) 2.4
Priestley, Professor J. H. 9.28
Prinskasteel Stream 4.19
Prior, D. C. 8.3
Profitability of afforestation 8.37, 9.5
115 PROGRESS OF FOREST ENTOMOLOGY IN SOUTH AFRICA. F. C. G. Tooke 10.4
116 PROGRESS OF STATE FOREST ADMINISTRATION. K. A. Carlson. (Letter) 1.62
PROPERTIES, TIMBER ITS STRUCTURE AND. H. E. Desch. (Review by J. M. T.) 1.65
117 PROPERTIES AND USES OF SOUTH AFRICAN KIAAT (PTEROCARPUS ANGOLENSIS) TIMBER, THE. M. H. Scott 7.61

PRUNING STUDIES IN THE MAIN EXOTIC CONIFERS GROWN IN SOUTH AFRICA. I. J. Craib 2.49
Pseudocedrata cylindricum 10.39
Pterocarpus angolensis 1.42
(PTEROCARPUS ANGOLENSIS) TIMBER, THE PROPERTIES AND USES OF SOUTH AFRICAN KIAAT. M. H. Scott 7.61
Pterocarpus soyauxii 10.39
PUBLICATIONS, GOVERNMENT, SERIALIZATION OF. (Editorial) 3.3
118 PULP AND PAPER-MAKING AS A SOUTH AFRICAN INDUSTRY. P. J. A. Loseby 2.56
Pycnantha kombo 10.39
Pycnopsis brachyptera 2.35

Quebracho 6.76, 79
Quiding, A., and Son, 5

Rainfall interception 3.74
RAINFALL INTERCEPTION BY FOREST CANOPIES, AN APPROACH TO THE STUDY OF. C. L. Wicht 6.54
119 RAINFALL AND STREAMFLOW AT THE CAPE. J. D. M. Keet 4.15
120 RAISING TRANSPLANTS OF INDIGENOUS TREE SPECIES FOR OPEN-ROOTED PLANTING, THE. F. S. Laughton 1.17
Rapanea melanophleos 1.25, 45
Rappengraben 7.37
121 RATE OF GROWTH AND HEALTH OF THE SOUTHERN PINES IN THE MIDLAND CONSERVANCY. S. P. Sherry 1.30
Rats, vlei, damage by in plantations 8.64
122 READ, THE LATE H. A. (Editorial) 8.1
Read, H. A. 9.1
Read, H. A., 41, 42, 185
Real yellowwood 1.19
RECLAMATION OF THE CAPE FLATS. AN ARBOR DAY ADDRESS. J. J. Kotze 5.73
123 RECLAMATION OF THE PORT ELIZABETH DRIFT SANDS, THE. N. L. King 2.5
Reconditioning of timber 8.94
Red currant 1.46
Red els 1.46
Regulasies betreffende die invoer van houtwurm-besmette hout 9.3
Regulations affecting the importation of borer-infested timber 9.3
Reinecke, O. S. H. *and* **C. L. Wicht**, 130
Reitz, Col. Deneys, 50
124 REKLAMESËELS VAN DIE VERENIGING, DIE. (Editorial) 5.3
125 RELATIONSHIP BETWEEN MODULUS OF RUPTURE AND WEIGHT IN SOUTH AFRICAN GROWN PINE TIMBER. John M. Turnbull 7.67
Research on timber 10.2
Reservoirs, stocking of with fish 8.4
REVIEWERS. See also "CONTRIBUTORS"
Anonymous, 10, 38, 49, 51, 60, 148, 166
C[raib], I. J., 107, 146, 176
E[ckbo], N. B., 25, 157
E[vans], I. B. P., 134
Legat, C. E., 167
L[oseby], P. J. A., 161, 181
M[arsh], E. K., 4
N[eethling], E. J., 36, 52, 85, 153, 175
S[cott], M. H., 156
S[herry], S. P., 43, 53, 104, 121
T[urnbull], J. M., 159
W[att], W. E., 155
W[icht], C. L., 73, 74
Rhine, Caesar's bridge over the 9.2, 55
Rhizophora racemosa 10.39
Rhodes, C. J. 1.14

Rhodes Scholars 1.10
Rhus legati 1.46
Riet-Valley, East India Company's post at 5.34
Rivers, stocking of with fish 7.4
126 RODENT DAMAGE IN PLANTATIONS AND ITS PREVENTION. D. H. S. Davis 8.64
127 ROLL OF HONOUR. (Editorial) 8.3
Rooiels 1.24
Rooikoppies Plantation 8.1
Rooikrans 2.6
Root collar rot 4.42
Round timber, the drying of 8.94
Run-off of rainwater 3.77
Ru-olie 3.86
Ryan, H. 3.109
Rysmiere 3.84

Saasveld School for Foresters 1.10
St. John's bread 4.78
SALIGNA GROWERS, UNITY AMONGST. E. T. E. Andrews (Letter) 5.90
Saligna gum 1.43
Salix babylonica 2.70
SAMPLING OF WATTLE BARK, THE GRADING AND. A. J. Taylor 8.103
Sankey, H. J. 3.109
Santa Ana Valley, California 7.37
Sapele 10.38
Sarcocephalus diderrichii 10.39
trilesii 10.39
Sawyers 1.10, 2.1
Scented guarea 10.38
Schauder, Leon 4.3
Schiemer, E. L., 59
128 SCHONLAND, PROFESSOR EMERITUS S. (Editorial) 4.3
School of Foresters 1.10
School, Forestry, for higher professional officers 1.10
Schöpslin 1.9
129 SCOPE OF THE JOURNAL. (Editorial) 4.1
Scott, John L. 4.7
Scott, M. H. 10.3, 60
Scott, M. H., 35, 75, 117, 135, 138, 158, 170
S[cott], **M. H.**, 156
Season for felling 8.74
Seasoning kilns 8.81
Seasoning, purpose of 8.73
Seasoning schedules 8.91
SEASONING, TIMBER, IN SOUTH AFRICA. M. H. Scott 8.70
Seepage 3.78
130 SEMI-EVERGREEN FORM OF LOMBARDY POPLAR, A. O. S. H. Reinecke *and* C. L. Wicht 9.19
131 SERIALIZATION OF GOVERNMENT PUBLICATIONS. (Editorial) 3.3
Sering, Wilde 1.45
Sering, Wit 1.45
Sherry, S. P., 98, 121
S[herry], **S. P.**, 43, 53, 104
SHOOK MANUFACTURERS GET TOGETHER, LUMBER MILLERS AND. Phil White 9.44
Shot-hole borer 10.11
SHRINKAGE OBSERVATIONS, FIBRIL BEHAVIOUR AS DISCLOSED BY. John M. Turnbull 5.62
Shrinkage in timber 8.72
Silver wattle bark 10.48
132 SIM, THE LATE DR. T. R. 1.1
Sim, Dr. T. R. 1.9
Sinkkloriede 3.86
Skoffeling as protection against rodents 8.68

Smith, C. A., 96
SKRYWERS VAN OORSPRONKLIKE ARTIKELS. Sien ook "MEDEWERKERS"
Ackerman, D. P., 16
Anoniem, 142
de Geus, H. L., 102
K[eet], J. D. M., 64
Krogh, P. M. D., 12
Loseby, P. J. A., 65
Malherbe, H. L., 82
van Wyk, J. H., 65
Wicht, C. L., 2
Winckworth, A. W., 178
133 SNAKE-BITE SERUM FOR THE FORCES. (Editorial) 7.2
SNAKE-BITE SERUM, SUPPLY OF FOR THE FORCES. E. H. Cluver. (Letter) 7.81
Snout beetle, eucalyptus 10.5
Softwood timber production, recommended State programme 9.10
Softwood timber, production by State 9.8
Softwood timber, Union's requirements 9.9
134 SOIL CONSERVATION. H. H. Bennett. (Review by I. B. P. E.) 6.104
SOIL RECLAMATION, EUCALYPTUS SALIGNA AND. H. A. Read 7.50
135 SOME WEST AFRICAN SUBSTITUTES FOR WELL-KNOWN TIMBERS. M. H. Scott 10.29
136 SOUTH AFRICA'S DEBT TO JOSEPH BURTT DAVY. Mary Gunn 5.10
137 SOUTH AFRICAN FORESTER HONOURED, A. (Editorial) 3.3
138 SOUTH AFRICAN GROWN FURNITURE WOODS. M. H. Scott 1.41
South African Lumber Millers' and Shook Manufacturers' Association 9.2, 44
139 SOUTH AFRICAN TIMBER INDUSTRIES AND THE WAR. (Editorial) 3.1
140 SOUTH AFRICAN WATTLE BARK AND WATTLE EXTRACT WITH SPECIAL REFERENCE TO THE AMERICAN MARKET. I. J. Craib 6.71
Spawning conditions for freshwater fish 6.18
Species used in State afforestation 1.12
Spergelgraben 7.37
Spiral grained wood, behaviour of in drying 5.67
Spirostachys africana 1.44
Splitting in timber 4.47, 5.84, 8.95
Spruce, stem profile of 9.26
STAIN, ANTI-, SOLUTIONS. A. Quiding & Son. (Letter) 10.60
STAMPS, THE ASSOCIATION'S PUBLICITY. (Editorial) 5.3
141 STANDAARD BENAMINGE VIR HOUTSOORTE IN SUID-AFRIKA GEKWEEK 5.75
142 STANDARD NOMENCLATURE FOR SOUTH AFRICAN GROWN TIMBERS 5.75
Stapleton, C. C., 27
Star grass 7.51
143 STATE AFFORESTATION AFTER THE WAR. I. J. Craib 9.5
STATE FOREST ADMINISTRATION, PROGRESS OF. K. A. Carlson. (Letter) 1.62
144 STATE POLICY REGARDING INDIGENOUS TREES. Gordon Leith. (Letter) 5.93
145 STATE SALES OF BLACK STINKWOOD TIMBER. (Editorial) 3.2
Stebbing, E. P. 8.123
STEEL AND CONCRETE, WOOD *versus*. (Editorial) 1.2
STEM DESIGN, A STUDY IN. John M. Turnbull 9.26
Stem form, control of by wood density 9.26
Stem run-off 6.58
STEMFLOW, INTERCEPTION AND, IN A PINE PLANTATION. Kittredge, Loughead *and* Mazurak. (Review by C. L. W.) 7.84
Stephens, R. P., 90
Stephens, R. P., *and* W. B. Goldschmidt, 111
Stinkwood compared with imbuia 5.29
for furniture 1.41
imported 5.29
raising of transplants of 1.22
restriction in use of name 7.1
State sales of 3.2

Stoate, T. N. 6.100
Stocking dams with fish 8.12
Streamflow 3.65
STREAMFLOW, RAINFALL AND, AT THE CAPE. J. D. M. Keet 4.15
Streams, gauging 3.66
improvement of for fish culture 6.4
stocking of with fish 8.12
Strength ratios 8.112
Strength/weight ratio in timber 7.67
Struben, Frank 9.1
Struben, Frank, 105
STRUCTURAL TIMBER DESIGN, HANDBOOK OF. I. Langlands *and* A. J. Thomas. (Review) 5.97
146 STUDY OF THE EFFECT OF SWAY IN TREES, A. M. R. Jacobs. (Review by I. J. C.) 5.95
147 STUDY IN STEM DESIGN, A. John M. Turnbull 9.26
Substitute timbers 10.51
SUBSTITUTE TIMBERS, CROSS-SECTION DIMENSIONAL ADJUSTMENT OF. John M. Turnbull 3.111
SUBSTITUTES FOR WELL-KNOWN TIMBERS, SOME WEST AFRICAN. M. H. Scott 10.29
148 SUITABILITY OF SUPPORTS USED UNDERGROUND ON THE WITWATERSRAND, THE. J. W. Bowen. (Review) 7.82
Sumach 6.77, 79
SUMMERWOOD RATIO IN PINE TIMBER, THE INFLUENCE OF AGE ON. John M. Turnbull 1.53
Sunfish, bluegill 8.6
149 SUPPLY OF SNAKE-BITE SERUM FOR THE FORCES. E. H. Cluver. (Letter) 7.81
SUPPORTS USED UNDERGROUND ON THE WITWATERSRAND, THE SUITABILITY OF. J. W. Bowen. (Review) 7.82
Sutton, Sir George 1.15
SWAY ON TREES, A STUDY OF THE EFFECT OF. M. R. Jacobs. (Review by I. J. C.) 5.95
SWAZILAND, NATIVE NAMES FOR TREES, SHRUBS AND OTHER PLANTS IN. O. B. Miller 6.89
SYLVICULTURE OF THE INDIGENOUS FORESTS, NOTES ON THE. F. S. Laughton 8.24
150 SYSTEMATIC BASIS FOR WOOD-USES RESEARCH, A. John M. Turnbull 10.51
Syzygium cordatum 1.60

151 TAALFOUTE. Bom. (Letter) 8.122
TAALGEBRUIK, AMPTELIKE. (Editorial) 8.2
Tambotie 1.44
TANNIN, WATTLE BARK, HISTOLOGICAL DISTRIBUTION OF. H. A. Luckhoff 10.40
Tanning materials 6.76
Taragama concolor 10.10
Taungya system of afforestation 1.7
Taylor, A. J., 56
Taylor, L. E. 3.109
TEAK, BURMA, AND ITS EXTRACTION. F. H. Wroughton 5.5
Tectona grandis 5.5
152 TEMPORARY TIMBER CHUTES AT DE HOEK PLANTATION. D. W. Pearse 2.72
Tench 8.10
Teragra guttifera 5.26, 10.10
Terblans 1.25, 45
Terminalia ivorensis 10.39
superba 10.39
Termites 2.14
Test sawing diagram, blanks in 7.72

153 TEXTBOOK OF DENDROLOGY COVERING THE IMPORTANT FOREST TREES OF THE UNITED STATES AND CANADA. W. M. Harlow *and* E. S. Harrar. (Review by E. J. N.) 3.118
154 THINNING, PRUNING AND MANAGEMENT STUDIES OF THE MAIN EXOTIC CONIFERS GROWN IN SOUTH AFRICA. I. J. Craib 2.49
155 THINNING, PRUNING AND MANAGEMENT STUDIES OF THE MAIN EXOTIC CONIFERS GROWN IN SOUTH AFRICA. I. J. Craib. (Review by W. E. W.) 3.121
Thomas, A. J. 5.97
Thrips, pine 10.9
Thunberg 5.32
Tierkloof 3.70, 10.16
TIMBER CHUTES AT DE HOEK PLANTATION, TEMPORARY. D. W. Pearse 2.72
156 TIMBER DRYING AND THE BEHAVIOUR OF SEASONED TIMBER IN USE. R. A. Bateson. (Review by M. H. S.) 3.123
TIMBER RESEARCH LABORATORY. TRANSVAAL CHAMBER OF MINES. ANNUAL REPORT 1939. (Review by P. J. A. L.) 6.104
157 TIMBER AND SAWMILLING INDUSTRIES, THE. (Review by N. B. E.) 3.124
158 TIMBER SEASONING IN SOUTH AFRICA. M. H. Scott 8.70
159 TIMBER, ITS STRUCTURE AND PROPERTIES. H. E. Desch. (Review by J. M. T.) 1.65
TIMBER SUPPLIES AND THE WAR, LOCAL. (Editorial) 5.1
Tokai Forestry School for Higher Professional Officers 1.10
Tokai Plantation, establishment of 1.6
Tokai School for Foresters 1.10
Tokai, South African School of Forestry 3.107
Tooke, F. C. C., 115
Top minnows, Gambusia 8.11
TORSION, A PRELIMINARY INVESTIGATION INTO THE CAUSES OF IN FINE STEMS. John M. Turnbull 8.112
160 TOXICITY OF SOUTH AFRICAN CREOSOTE, THE. J. H. van Wyk *and* Len Verwoerd 1.47
Trade survey committee 10.29
Tradouwsberg 5.38
Transkei, inauguration of wattle plantations in the 1.7
TRANSPLANTS OF INDIGENOUS TREE SPECIES FOR OPEN-ROOTED PLANTING, THE RAISING OF. F. S. Laughton 1.17
161 TRANSVAAL CHAMBER OF MINES. TIMBER RESEARCH LABORATORY. ANNUAL REPORT FOR 1939. (Review by P. J. A. L.) 6.104
Transvaal Chamber of Mines's Timber Research Laboratory 8.2
TREES, BIG. (Editorial) 5.3
162 TREE-PLANTING FOR COMMERCIAL PURPOSES. N. L. King 8.37
Trichilia cedrata 10.39
Triplochiton johnsonii 10.39
scleroxylon 10.39
163 TROUP, PROFESSOR, DEATH OF. (Editorial) 3.5
Trout, brown 7.4
rainbow 7.5
stocking 7.17
stripping 7.24
Troxell, H. C. 7.42
Turnbull, John M., 25, 46, 72, 110, 125, 147, 150
Turnbull, John M., *and* **P. M. D. Krogh,** 71
T[urnbull], **J. M.,** 159
Turreanthus nigra 10.39

164 um-DONI OR WATERWOOD (SYZYGIUM CORDATA). S. St. C. Ballenden 1.60
165 UNIE SE HOUT INVOER, DIE. (Editorial) 3.2
166 UNION OF SOUTH AFRICA: REPORT OF THE DIVISION OF FORESTRY FOR THE YEAR ENDED 31.3.38. (Review) 2.79
167 UNION OF SOUTH AFRICA: REPORT OF THE DIVISION OF FORESTRY FOR THE YEAR ENDED 31.3.41. (Review by C. E. Legat) 9.59
168 UNITY AMONGST SALIGNA GROWERS. E. T. E. Andrews. (Letter) 5.90

169 UNWELCOME VISITORS. (Editorial) 8.2
170 UTILIZATION OF SOUTH AFRICAN GROWN EUCALYPTUS SALIGNA. M. H. Scott 4.46

Valonia 6.76, 79
171 VALUE OF AN IMMATURE PLANTATION, THE. A. J. O'Connor 6.49
172 VALUE OF AN IMMATURE PLANTATION, THE. (Letters). Interested 9.56
N. L. K. 8.118
Laird 7.78, 8.119, 9.57
173 VAN DER BYL, THE LATE PROFESSOR P. A. (Editorial by E. J. N. *and* L. V.) 3.4
van der Merwe, C. C., P. J. A. Loseby *and*, 91
van der Stel, Simon 1.14
van Wyk, J. H., *and/en* **P. J. A. Loseby**, 65, 113
van Wyk, J. H., *and* **Len Verwoerd**, 160
Vanderplank, John 1.15
174 VARIABILITY OF JONKERSHOEK STREAMS, THE. C. L. Wicht 10.13
175 VEGETATION OF SOUTH AFRICA. R. S. Adamson. (Review by E. J. N.) 1.64
176 VEGETATIVE REPRODUCTION OF FOREST TREES. M. R. Jacobs. (Review by I. J. C.) 5.96
VEGETATIVE REPRODUCTION OF PINUS INSIGNUS, A NOTE ON THE. S. P. Sherry 9.23
Vegetative reproduction of *Pinus radiata* 5.98
Vernon brothers 3.109
V[erwoerd], **L., E. J. N**[eethling] *and*, 173
Verwoerd, Len, J. H. van Wyk *and*, 160
Virgin forest, a 5.38
177 VISITOR FROM JAVA, A. (Editorial) 2.3
Vlei rats, damage by in plantations 8.65
Voles in plantations 8.64
Von Mueller, Baron 5.93

Wagon Wheel Gap 10.16
Wallis, J. P. R., 21
WAR, LOCAL TIMBER SUPPLIES AND THE. (Editorial) 5.1
WAR, SOUTH AFRICAN TIMBER INDUSTRIES AND THE. (Editorial) 3.1
Warping 8.96
178 WAT STEEK DAAR IN 'N NAAM? A. W. Winckworth 2.70
Water pear 1.46
Watermeyer, F. G. 4.7
Waterwood 1.60
Watt, W. E. 10.2
W[att], **W. E.**, 155
Wattle bagworm 10.4
bark, anatomy of 10.40
bark and extract, consumption of in U.S.A. 6.82
bark and extract, world trade in 6.82
WATTLE BARK, THE GRADING AND SAMPLING OF. A. J. Taylor 8.103
bark, grading of 6.74, 8.103
bark, green 10.48
bark, Java 10.49
WATTLE BARK IN THE LEATHER TRADE, THE PLACE OF. J. D. M. Neet 1.51
Wattle bark, silver 10.48
WATTLE BARK TANNIN, HISTOLOGICAL DISTRIBUTION OF. H. A. Luckhoff 10.40
WATTLE BARK AND WATTLE EXTRACT, SOUTH AFRICAN, WITH SPECIAL REFERENCE TO THE AMERICAN MARKET. I. J. Craib 6.71
Wattle culture: fertilising 4.71
WATTLE PATHOLOGY, A PRELIMINARY REPORT ON SOME ASPECTS OF. R. P. Stephens *and* W. B. Goldschmidt 2.31
Wattle plantations in the native territories, inauguration of 1.7, 2.75
WATTLE SILVICULTURE, MINING TIMBER IN SOUTH AFRICA WITH SPECIAL REFERENCE TO. R. P. Stephens 4.55

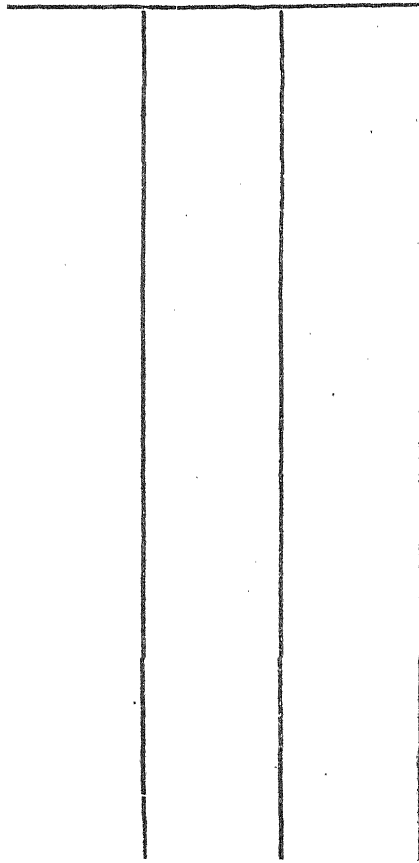
Wattle sylviculture 6.72
tans 6.75, 79
Wattles, tan, beginning of the industry 1.15
WATTLES, DEVELOPMENT OF PATHOLOGICAL RESEARCH ON. M. S. J. Ledeboer 4.30
hoeing 4.72
leaf shedding 2.39
pruning 4.70
rotation 4.72
thinning 4.70
179 WEANING THE NATIVES FROM THE NATURAL FORESTS IN THE NATIVE TERRITORIES. K. A. Carlson. (Letter) 2.75
Weather conditions, evaluation of 5.98
Webber 2.6
Weidman, R. H. 6.102
Weight/strength relationship in pine timber 7.67
WEST AFRICAN SUBSTITUTES FOR WELL-KNOWN TIMBERS, SOME. M. H. Scott 10.29
180 WHAT'S IN A NAME? Monniker. (Letter) 6.98
White, Phil. 86
Wicht, Dr. C. L. 10.3
Wicht, C. L., 2, 7, 28, 33, 47, 174
W[icht], **C. L.,** 73, 74
Wicht, C. L., O. S. H. Reinecke *and*, 130
Wilde sering 1.45
Williams 2.9
Willows, The 5.93
Willow-tree caterpillar 10.9
Wilmot, G. A. 3.109
Winckworth, A. W., 178
Wit els 1.44
Wit sering 1.45
WITWATERSRAND SHOW, FORESTRY AT THE. (Editorial) 4.3
WITWATERSRAND, THE SUITABILITY OF SUPPORTS USED UNDERGROUND ON THE. J. W. Bowen. (Review) 7.82
181 WOOD PRESERVATION. G. M. Hunt *and* G. A. Garratt. (Review by P. J. A. L.) 4.86
Wood preservation, the economics of 2.29
182 WOOD PRODUCTION AND UTILIZATION. (Editorial) 1.2
183 WOOD *versus* STEEL AND CONCRETE. (Editorial) 1.2
WOODCUTTER PROBLEM, THE KNYSNA FORESTS AND THE. N. L. King 3.7
Woodcutters 1.10, 2.1
184 WOODCUTTERS' ANNUITY ACT, THE. (Editorial) 2.1
185 WOODEN HOUSES. H. A. Read 2.44
WOOD-USES RESEARCH, A SYSTEMATIC BASIS FOR. John M. Turnbull 10.51
Worcester Plantation 1.6
Wroughton, F. H., 19

Yellowwood for furniture 1.43
Yield from State forests 1.2
Young, H. E. 6.100

Zinc chloride 2.17
ZULULAND, NORTHERN, DESTRUCTION OF NATIVE FORESTS IN. J. D. M. Keet. (Letter) 3.115
ZULULAND, NORTHERN, THE FORESTS OF. Deneys Reitz 1.28

IMPERIAL COUNCIL OF AGRICULTURAL
RESEARCH LIBRARY

This book was taken from the Library on the date last stamped.



Indian Agricultural Research Institute (Pusa)
LIBRARY, NEW DELHI-110012

This book can be issued on or before .....

Return Date	Return Date